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APRIL 1961

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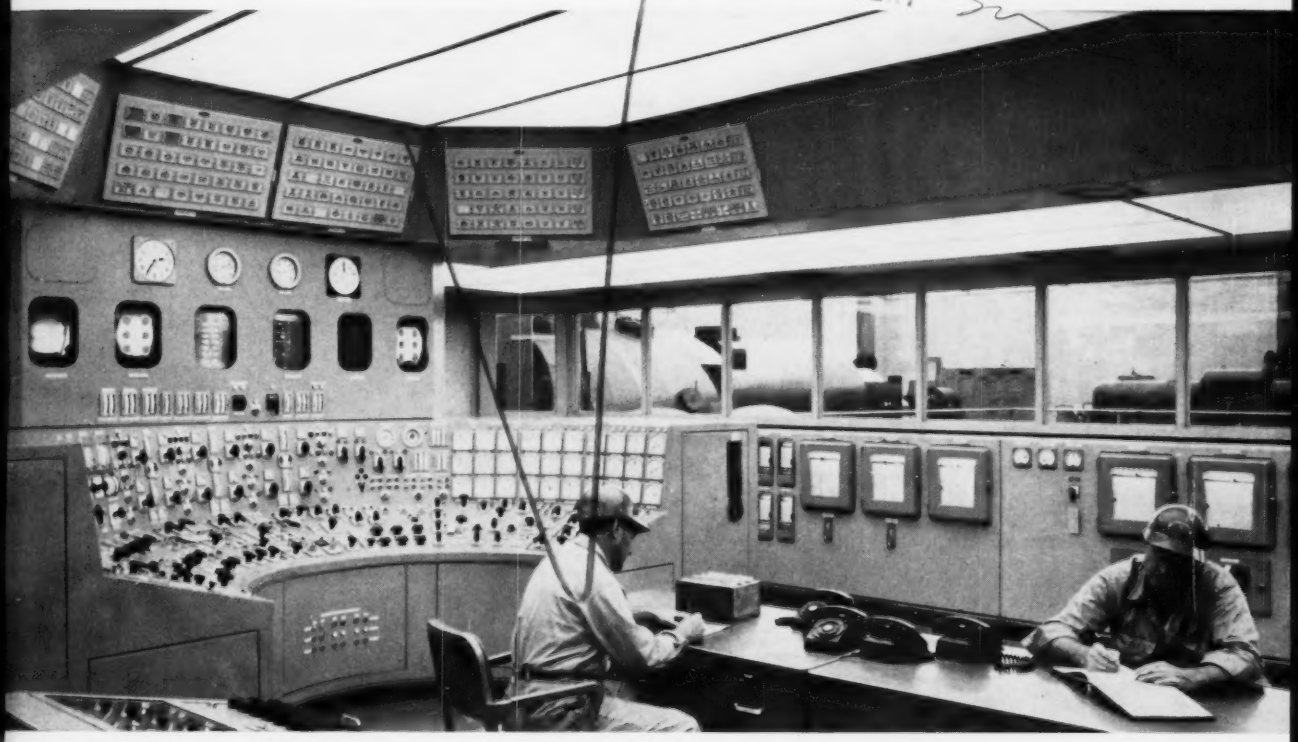
the magazine of energy systems engineering



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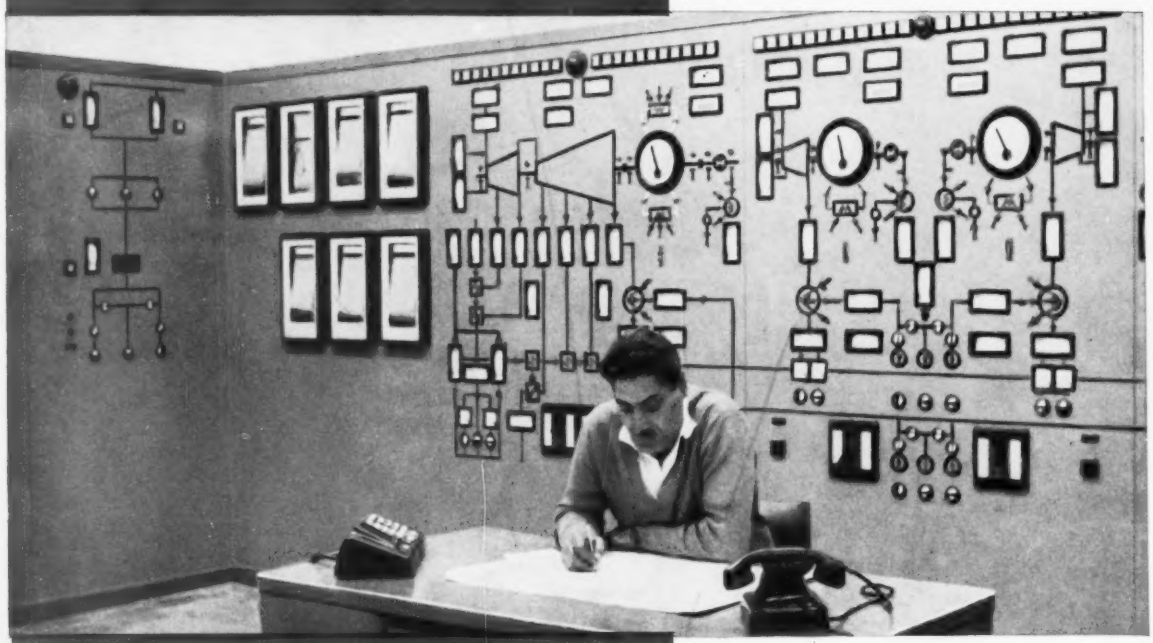
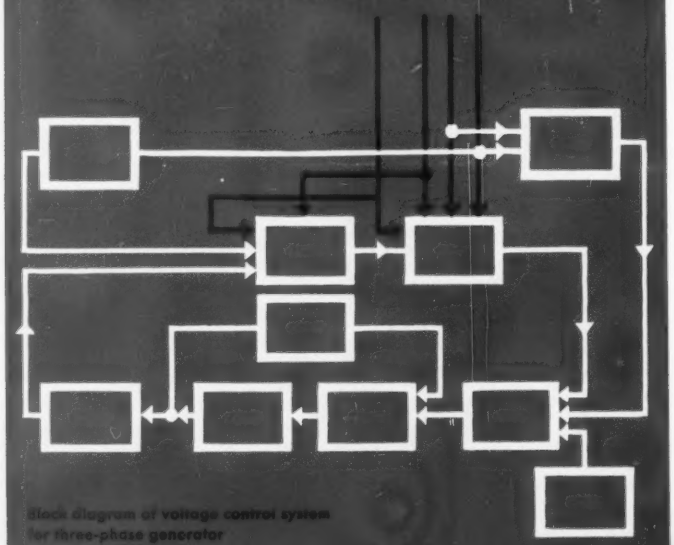


View of AEG thermal control board in a new steam power station



Block diagram of voltage control system for three-phase generator

If its Automation - consult

- Measuring instruments
- Precision instrument equipment
- Indicating instruments and recorders
- Electricity meters
- Machine-tool control equipment
- Remote control systems
- Photo-electric elements
- Industrial tubes
- Reactive power limiters
- Voltage regulators
- Temperature controllers
- 'Logistat' Unit control system

AEG

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Berlin (West) EXPORT DEPARTMENT Frankfurt (Main)

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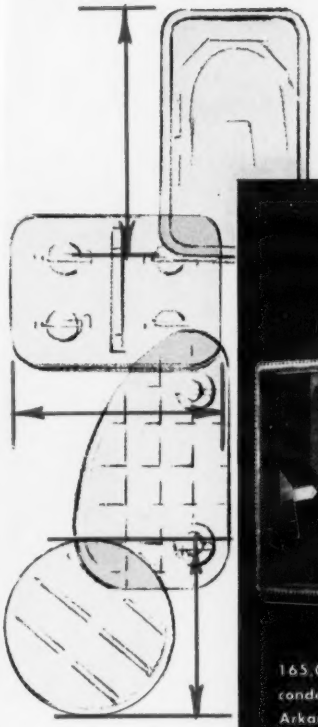

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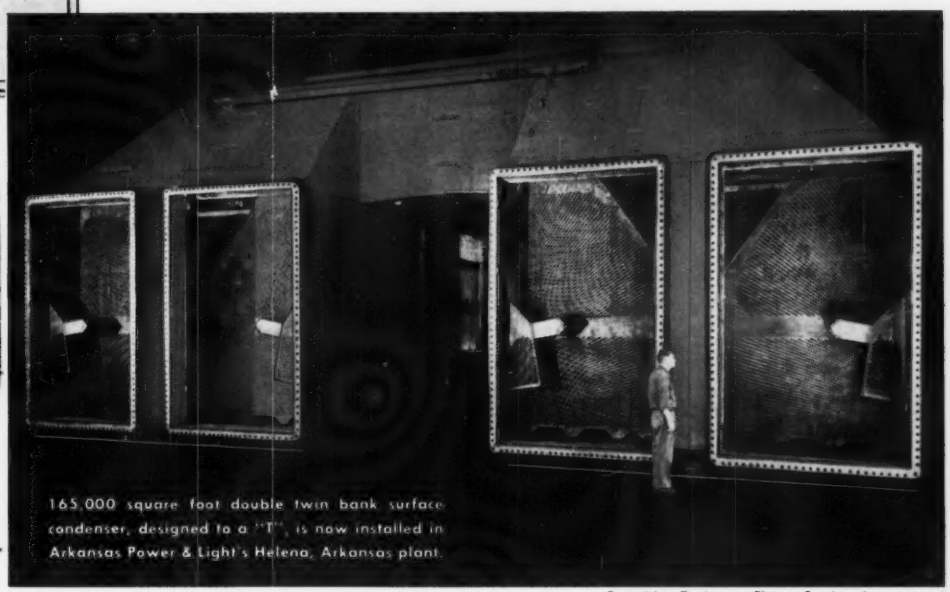
ANY SIZE . . . ANY ARRANGEMENT



165,000 square foot double twin bank surface condenser, designed to a "T", is now installed in Arkansas Power & Light's Helena, Arkansas plant.

Consulting Engineers: Ebasco Services Incorporated

MOST VERSATILE TUBE BANK LAYOUT IN THE INDUSTRY

YUBA SURFACE CONDENSER DESIGN . . . most flexible . . . any size . . . any arrangement. Through design advances such as those incorporated in the unit above, Yuba illustrates the concepts you can expect from years of engineering leadership in the power industry.

Yuba's twin-bank tube layout, seen here in a two shell "T" type installation, promotes unobstructed, equally distributed flow. Through Yuba's patented design, the condensate can be deaerated with oxygen content guaranteed to be less than 0.005 cc per liter.

As a design extra, Yuba staggers the tube support plates – reducing harmonics – eliminating vibration. These are some of the reasons why Yuba surface condensers of all sizes have been installed in plants throughout the world. You'll want to know more about the most versatile tube bank layout in the industry – contact Yuba today.

Other Yuba products for steam power plants include feedwater heaters, evaporators, expansion joints, cranes, tanks, structural steel erection, and scores of other items.

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speaking of **Power**

Farming out work, on both the design and maintenance level, is practiced to varying degrees by energy-systems engineers. Reasons generally given for calling in outsiders: to handle peak work loads, without increasing basic staff size, or to get expert help on specialized jobs needing a background in skills too little used to keep men on the payroll full time.

Of late the maintenance side of our business has been a growing target for consultants and contractors. Maintenance consultants offer an enticing service package on the overall planning of plant-maintenance programs (POWER, February 1961, pp 173-175). And firms geared to carry out such plans by contract maintenance are growing in number. Both service groups have a tremendous potential market —for every dollar of net profit made by American industry, some 67¢ was paid out for maintenance and repair.

Contract maintenance has been with us in a modest form for many years. Typical: letting out some portion of electrical responsibility, the elevators, say, to companies qualified to do all the maintenance and repair needed. Today we have established organizations ready to move in on just about any plant and take over all maintenance.

Like the concept of using consultants on any job, the idea of turning over all but management and liaison responsibility for plant maintenance to an outside firm has many people in favor, many who resist. It's a decision you must make—wisely. Your final recommendation will be based on whether or not maintenance contractors can do a job of the quality you demand at a lower cost than you could with your own staff.

Next month Associate Editor Steve Elonka looks at the overall possibilities for contract maintenance in a *Today's Development* report. He will outline the case for and against and reveal the findings of one big plant which went whole hog for contract maintenance. Watch for it!

Lou Rowley

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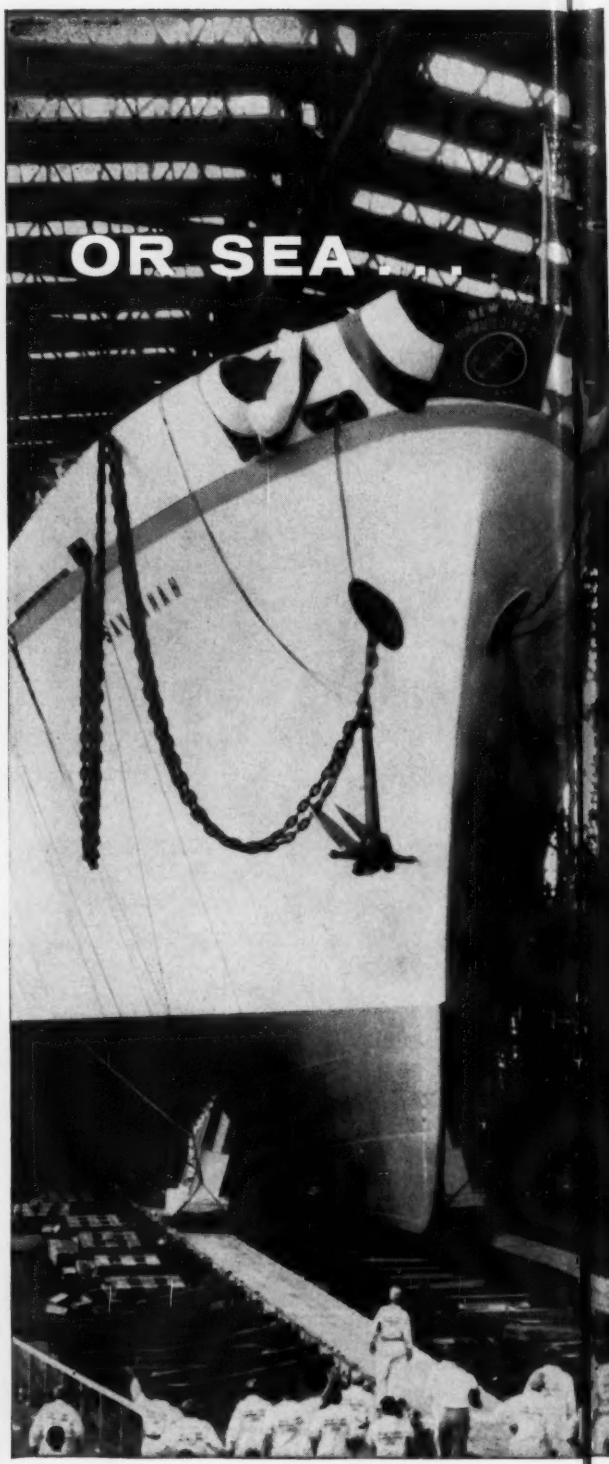
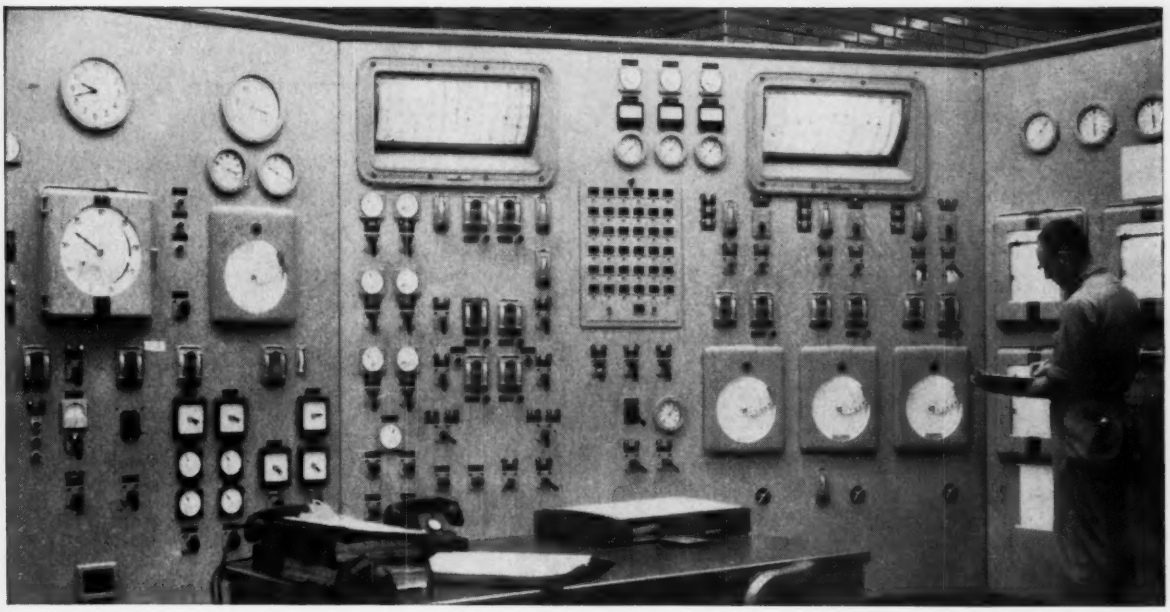
At Milliken Station, New York State Electric and Gas Corporation, Bailey METROTYPE Information Systems monitor operating conditions and gather performance data. The monitoring system continuously scans all points and prints out any off-normal measurements while the performance system makes hourly logs and simultaneously produces punched tape for future use in standard digital computing facilities.



The NS Savannah, first Nuclear merchant ship, is controlled fro a "Bailey Board" which includes Nuclear Instrumentation an Bailey Reactor Controls as well as Bailey Steam Plant Instr ments and Controls.

This is the control center for the first commercial super-critical pressure, steam-electric unit in America. Here at the Philo plant of the Ohio Power Company, on the American Electric Power Company System, Bailey controls maintain the desired rate of steam generation, final steam temperature and optimum combustion conditions.

IT'S BAILEY. . .



for the latest and safest instruments and controls for nuclear and conventional power plants!

Many of the power plants of the future will have controls and instruments designed and built by Bailey. There are two reasons: Bailey's continuing research and development toward the latest equipment for industry's needs; Bailey's 40-year association with the hardware and economic requirements of the industry.

If you are planning new or improved power plant facilities, call on Bailey engineers to insure that your system will have the *proper balance both as to economics and needs . . . that there will not be the unnecessary expense of over-instrumentation or control . . . nor the duplication of equipment functions.*

Call on Bailey for primary sensing devices, indicators, loggers, control units, panels, data handling equipment, computers for performance analysis, and supervisory controls. You'll find designs ranging from conventional to the most sophisticated . . . mechanical, pneumatic, electric and electronic, including solid state.

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Diamond developed for more economical power

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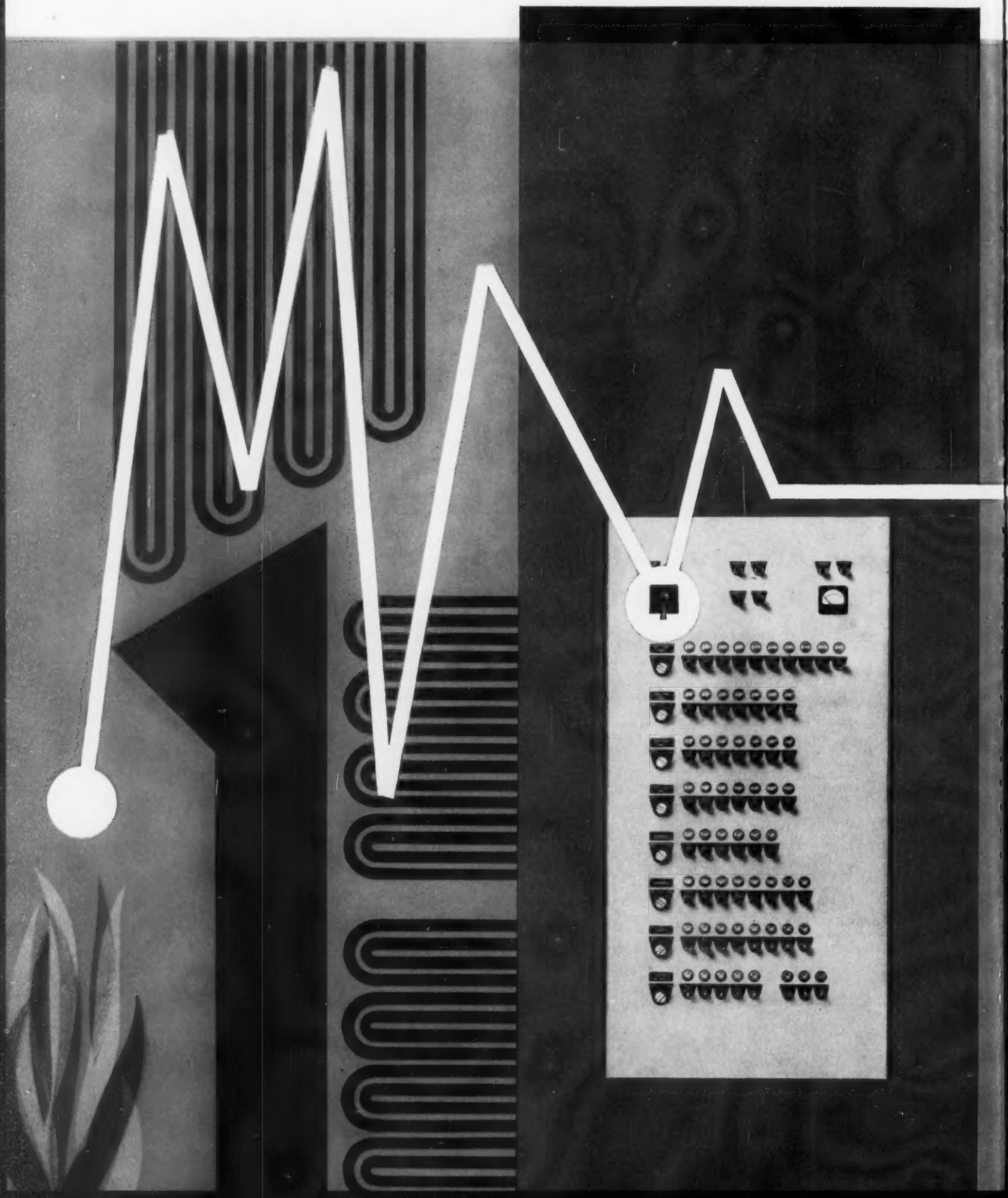

Optimum frequency of blower cycling is assured with Monitormatic . . . Diamond's completely automatic boiler cleaning system.

Monitormatic is an automatic method of maintaining constant furnace cleanliness and heat absorption. It responds automatically to changing boiler conditions and eliminates indiscriminate, unnecessary or insufficient blowing. Savings are realized through optimum use of blowing medium, minimized soot blower maintenance, less compressor maintenance if air is used as blowing medium, and reduced operator time. It also automatically adjusts the cleaning system to fuel changes.

Monitormatic is readily and economically applicable to new or many existing Diamond Selectromatic Systems; is another example of why "Diamond Developed" means more economical power generation.

At your request, our Engineers will be pleased to evaluate the application of Monitormatic to your specific system. Call, write or wire for complete information.

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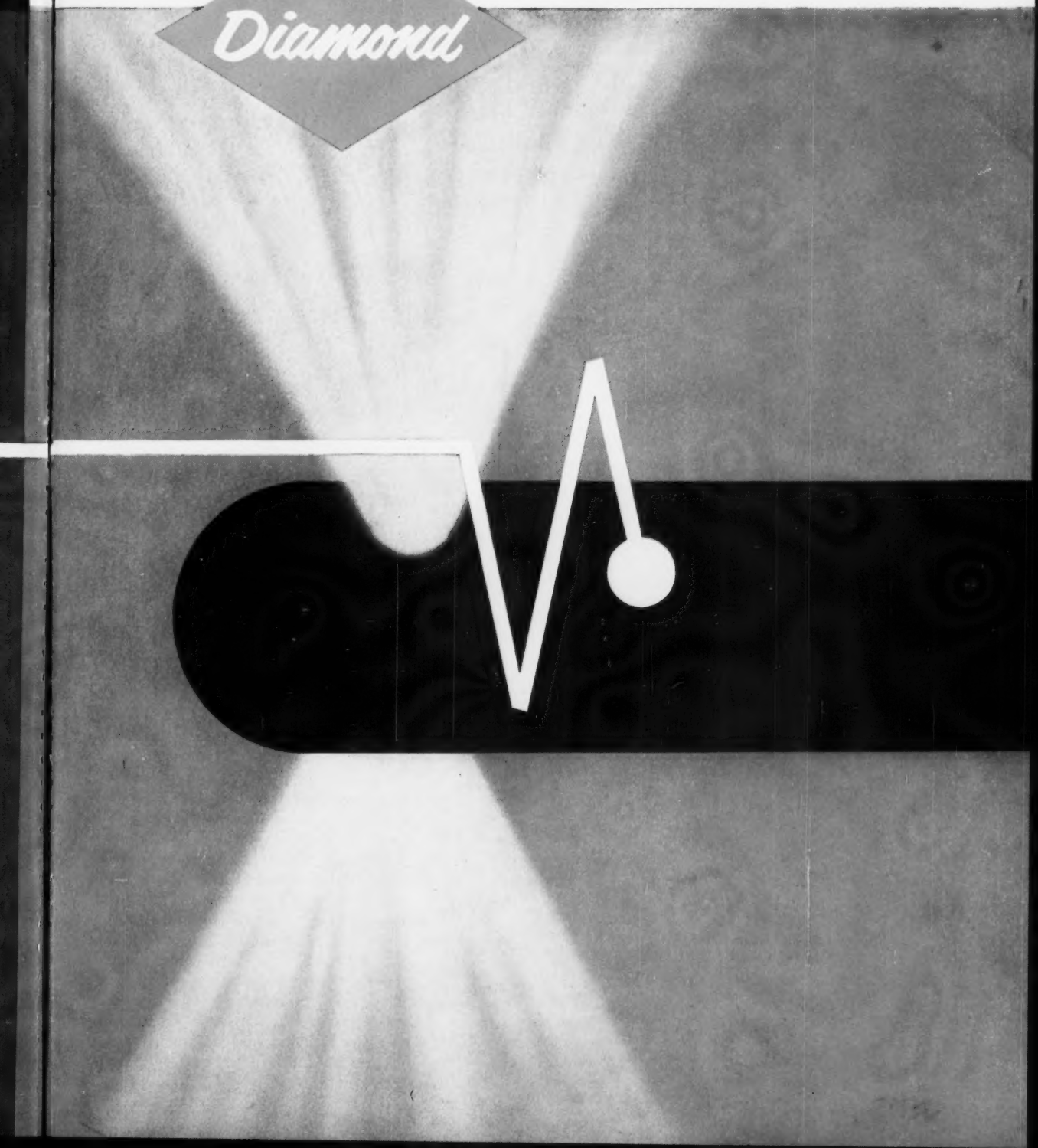
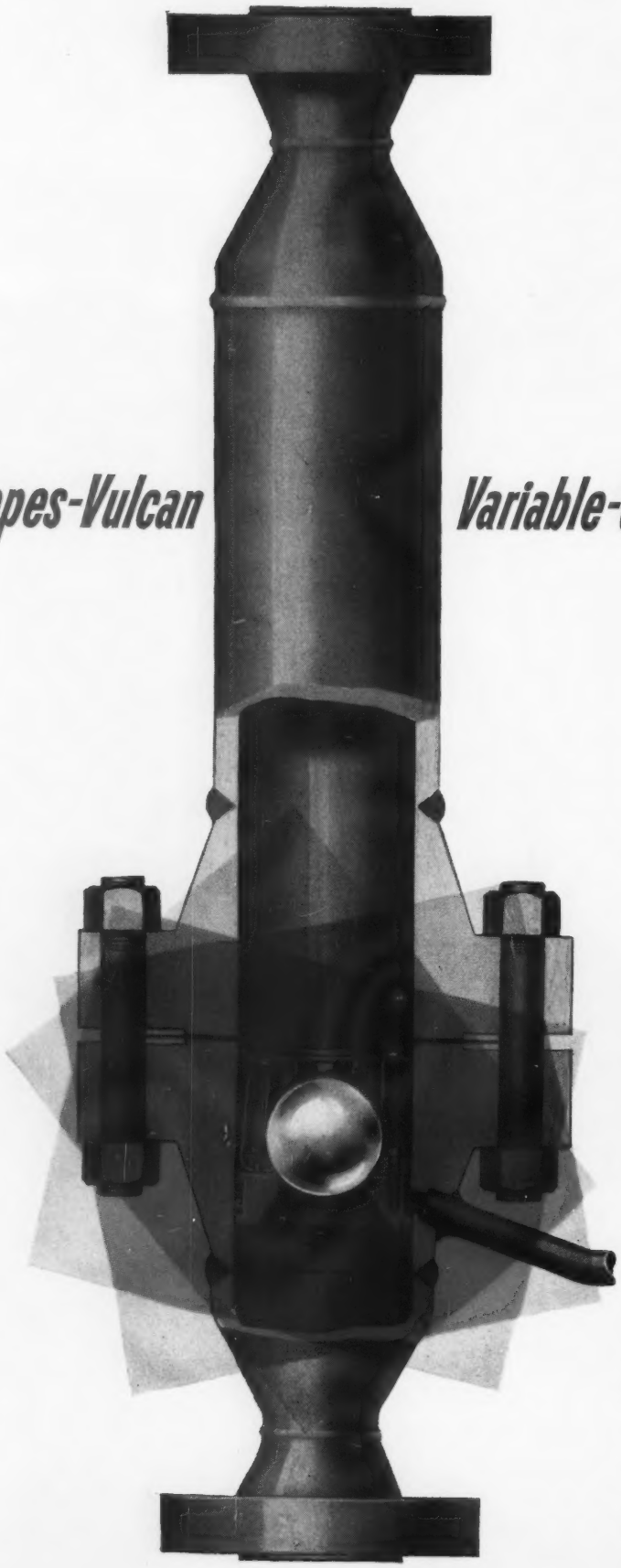


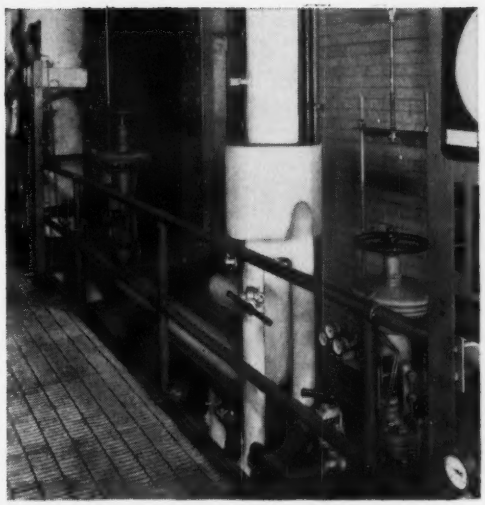
Copes-Vulcan Variable-Orifice desuperheater



This ball makes the difference. Steam pressure lifts a weighted steel ball off its ring seat to a position where it is balanced by steam pressure and flow through the orifice. The ball is held concentric by Inconel springs and rigid guides. This is the only moving part in the Copes-Vulcan Variable-Orifice desuperheater that so effectively controls steam temperature.

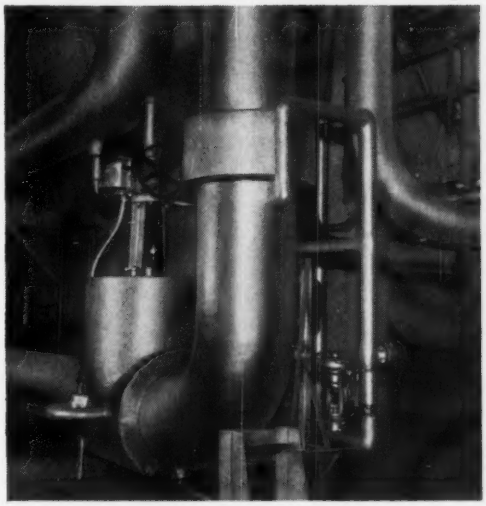
Cooling water enters through an annular orifice surrounding the ring seat at the point of maximum steam velocity. The passage of steam through the annular restriction between ball and seat produces an aspirating effect on the cooling water and entrains it in an area of high turbulence over the full range of flow.

No long run of piping is needed to mix the two fluids. There is no excess water to remove. No atomizing steam is used. There are no glands, stuffing boxes or spray nozzles. Pressure drop remains constant for all flows, and is normally 3 to 4 psig. Write for Bulletin 1037.



The problem: to maintain the temperature of residual fuel oil at 335°-380°F using station steam at 1250 psig and 950°F. Because of the high temperature heating requirements of the fuel, it was necessary to use the station steam supply. To handle this tough assignment a single, combination pressure-reducing and regulating valve, Copes-Vulcan Type CV-D, followed by the Copes-Vulcan Variable-Orifice desuperheater was used. The cooling-water valve is also a Type CV-D. The desuperheater provides steam at the right temperature to control the fuel oil temperature and viscosity exactly. It has been in service over two years with no downtime and no operating problems.

solves knotty problems at two generating plants



The problem: to deliver 420°F steam at from 20,000 to 300,000 pounds per hour and within ± 5°F of the set point. Conventional desuperheating equipment could not be used because of the low superheat (30°F) and low flow conditions. A 12-inch, 300-psig standard Copes-Vulcan Variable-Orifice desuperheater, with outlet expanded to 20-inch pipe size, was the answer. The inlet is connected with the main steam-distribution header carrying steam at 220 psig and 500°F. The cooling-water supply is at 450 psig and 200°F. The specified pressure range is 425 to 475 psig. Cooling-water flow is automatically regulated by a Copes-Vulcan Type CV-D valve operated by a temperature controller in the steam heating supply line. Flow requirements at discharge temperature within ± 5°F have been met consistently though inlet temperatures vary from 520°F to 550°F.

Copes-Vulcan desuperheaters are designed for precise control of reduced steam temperatures under the most difficult operating conditions.

In addition to the Variable-Orifice, two other types are available. *The Carburetor-Type desuperheater* injects cooling water into the system with a spray nozzle. Available in standard 2-inch through 12-inch sizes in 150- through 600-pound pressure standard for cast steel. Larger sizes and higher pressure standards are available on special application. Write for Bulletin 1056.

Steam-Assist desuperheater has negligible permanent pressure loss on loads of 15% to 100% of maximum. This in-line desuperheater normally uses assisting steam only on light loads where control is most difficult. Write for Bulletin 1024-A. Copes-Vulcan Division, Erie 4, Pennsylvania.

Copes-Vulcan Division

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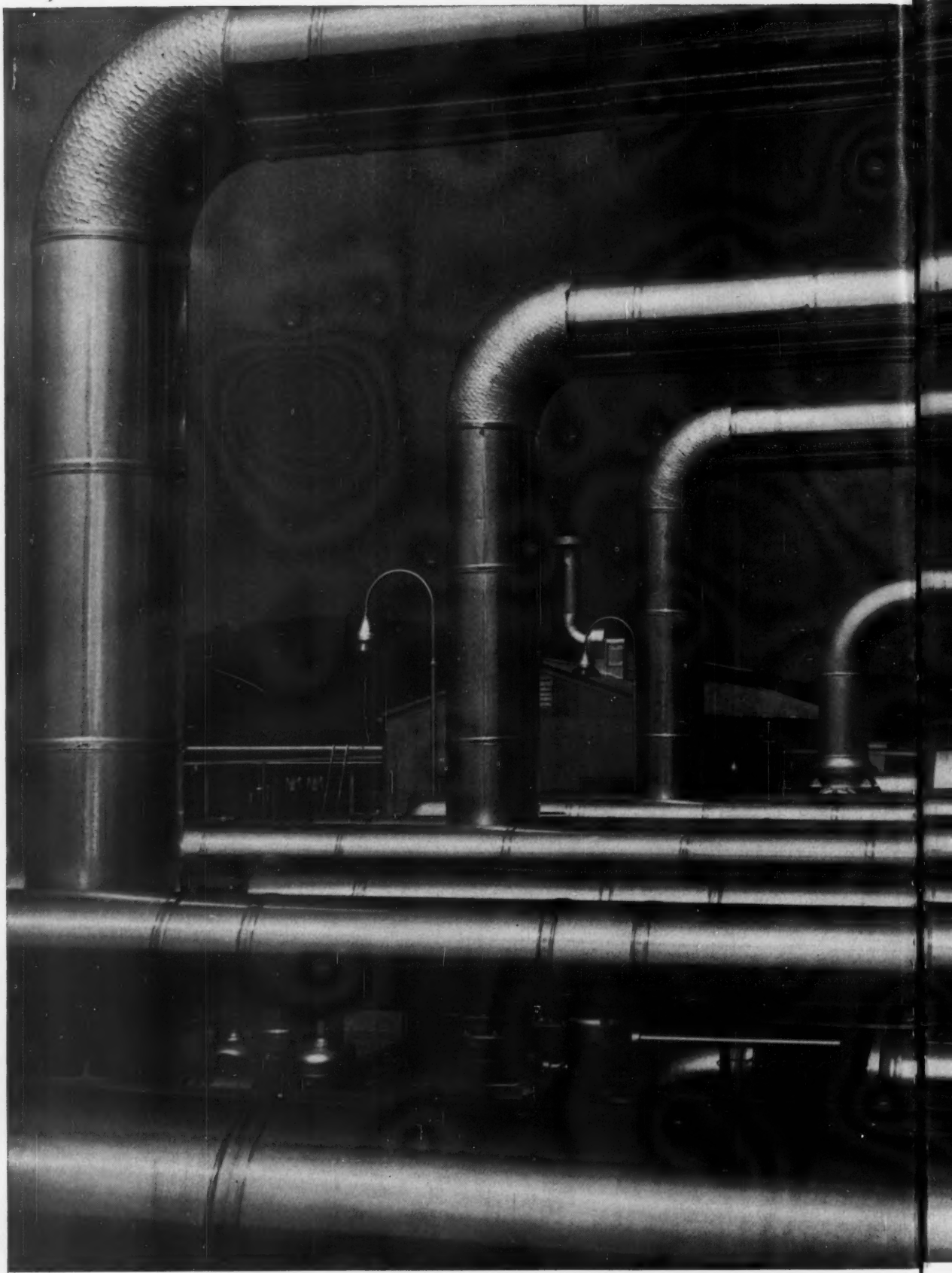
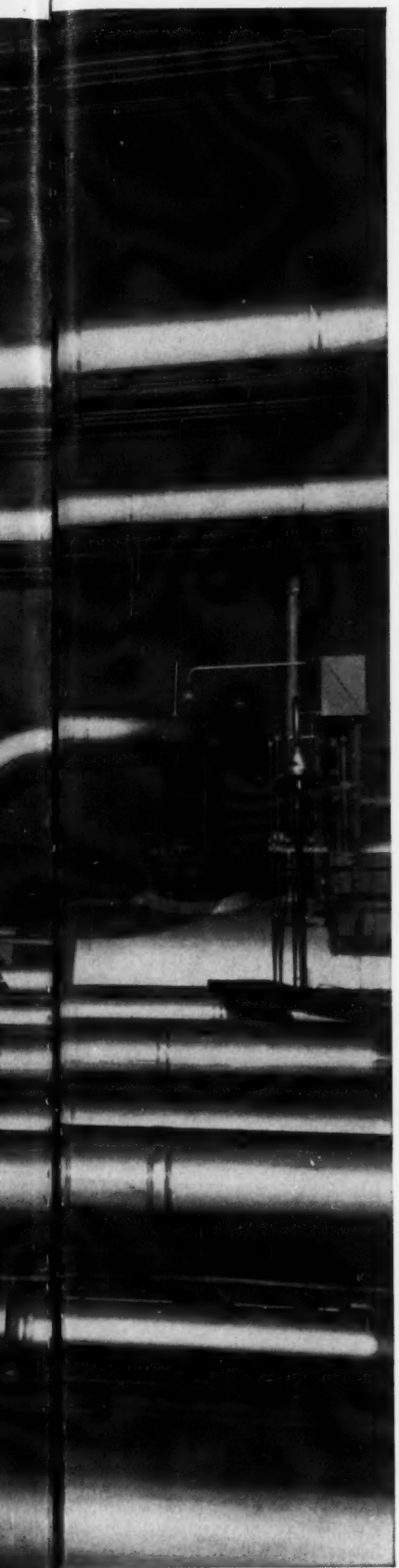


PHOTOGRAPHED AT NEW YORK STATE NATURAL GAS CORPORATION'S LEIDY COMPRESSOR STATION, TAMARACK, PA.



Installation time at Leidy Station cut 25% with prejacketed J-M METAL-ON® pipe insulation!

"ALMOST 2 MILES OF METAL-ON PROTECTS OUR OUTDOOR PIPELINES. THIS IS THE BEST–AND BEST-LOOKING–INSULATING JOB I'VE EVER SEEN,"
says head station engineer VICTOR CUMMINGS

Leidy Pool, with an ultimate storage capacity of 105.6-billion cubic feet of natural gas, is served by a compressor station incorporating almost two miles of outdoor pipelines. Both lines and equipment must be completely protected against northern Pennsylvania's violent winter storms, torrential spring rains and summer heat. Metal-On jacketing, developed by J-M, was chosen to handle this difficult job.

Metal-On is prefabricated at the factory in 36-inch lengths. Each length combines high-temperature J-M Thermobestos insulation . . . a moisture barrier . . . and a special aluminum alloy jacket. And because each length can be applied in one simple operation, erection time savings at Leidy averaged 25%! Metal-On can also be easily cut on the job with portable power or hand saws. Cutouts for hangers and supports are simple to make.

Maintenance savings can be very impressive, too. Metal-On doesn't corrode, needs no painting. The rugged jacketing, combined with a locking device that snaps closed and seals joints, will lock out weather and moisture permanently. And each section can be easily removed for trouble-shooting.

You may not have *two miles* of pipeline . . . but if you have a tough outdoor insulation problem, it will pay you to investigate J-M Metal-On. Just write to Johns-Manville, Box 14, New York 16, N. Y. In Canada: Port Credit, Ontario.

METAL-ON:
JUST MINUTES FROM CARTON TO PIPE!

JOHNS-MANVILLE
AN INSULATION FOR EVERY COMMERCIAL AND INDUSTRIAL USE

JOHNS MANVILLE JM PRODUCTS

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WATER LEVEL INDICATION ?

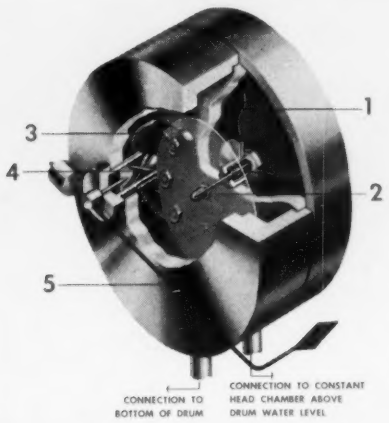
YARWAY REMOTE INDICATORS HAVE BRILLIANT "WIDE ANGLE" VISIBILITY... CAN BE INSTANTLY READ FROM MULTIPLE VANTAGE POINTS

Yarway Remote Liquid Level Indicators bring distant, often hard-to-see boiler level readings right down to eye level on the panel board or other convenient location.

No matter where you stand—at any point in a 180° arc, and from a considerable distance—the brilliant new wide vision dial makes viewing and reading easy.

GIVE INSTANT, ACCURATE READINGS BECAUSE INDICATOR IS OPERATED BY THE BOILER WATER ITSELF

Remote readings of levels in boilers (also feed water heaters and other heat exchangers) are instant and accurate because indicator *operating mechanism* is actuated by the varying head of the liquid itself, yet the *pointer mechanism* is never under pressure.



Constant pressure from a controlled-temperature constant head chamber located above drum level is maintained on one side of diaphragm (1) in indicator. Varying pressure changing with water level is maintained on opposite side of diaphragm. Change in differential between the two pressures moves the diaphragm which in turn regulates, through deflection plate (2), magnet (3), and spiral magnetic armature (4), the position of the counterbalanced pointer (5).

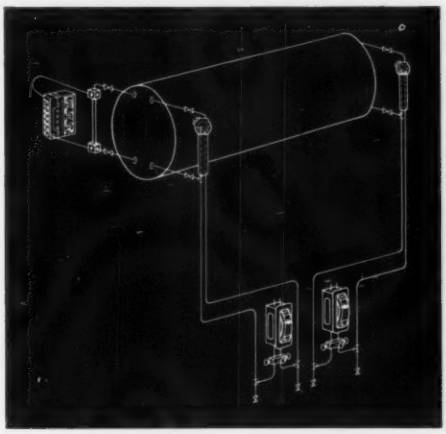
OPERATE ADDITIONAL REMOTE SIGNAL ALARMS, HORNS OR LIGHTS

With the addition of a control unit Yarway Indicators may be equipped to operate auxiliary hi-lo signal alarms, horns or lights located at any place in the plant. Electronic secondary indicators may also be used to duplicate readings at remote points.

FULLY APPROVED AS PRIMARY INDICATING ELEMENTS UNDER BOILER CODE CASE #1155

Under A.S.M.E. Boiler Code Committee ruling in Case #1155, two independent remote level indicators of compensated manometric type may be used instead of one of two required gage glasses for boiler pressures 900 psi and above. When both indicators are in operation, the gage glass may be shut off but shall be maintained in serviceable condition.

Yarway Remote Liquid Level Indicators conform to this ruling and are used widely for primary boiler water level indication in plants operating at 900 psi and above



All Yarway Indicators for service over 700 psi are temperature-compensated; pressure compensation available when desired. Use of controlled-temperature column on constant head chamber fully protects against system upsets.

If you would like a reprint of this Boiler Code ruling, just ask for Case #1155 reprint.

Get the full story on Yarway Liquid Level Indication for your plant. Write for new 24-page Bulletin RI-1825.

YARNALL-WARING COMPANY

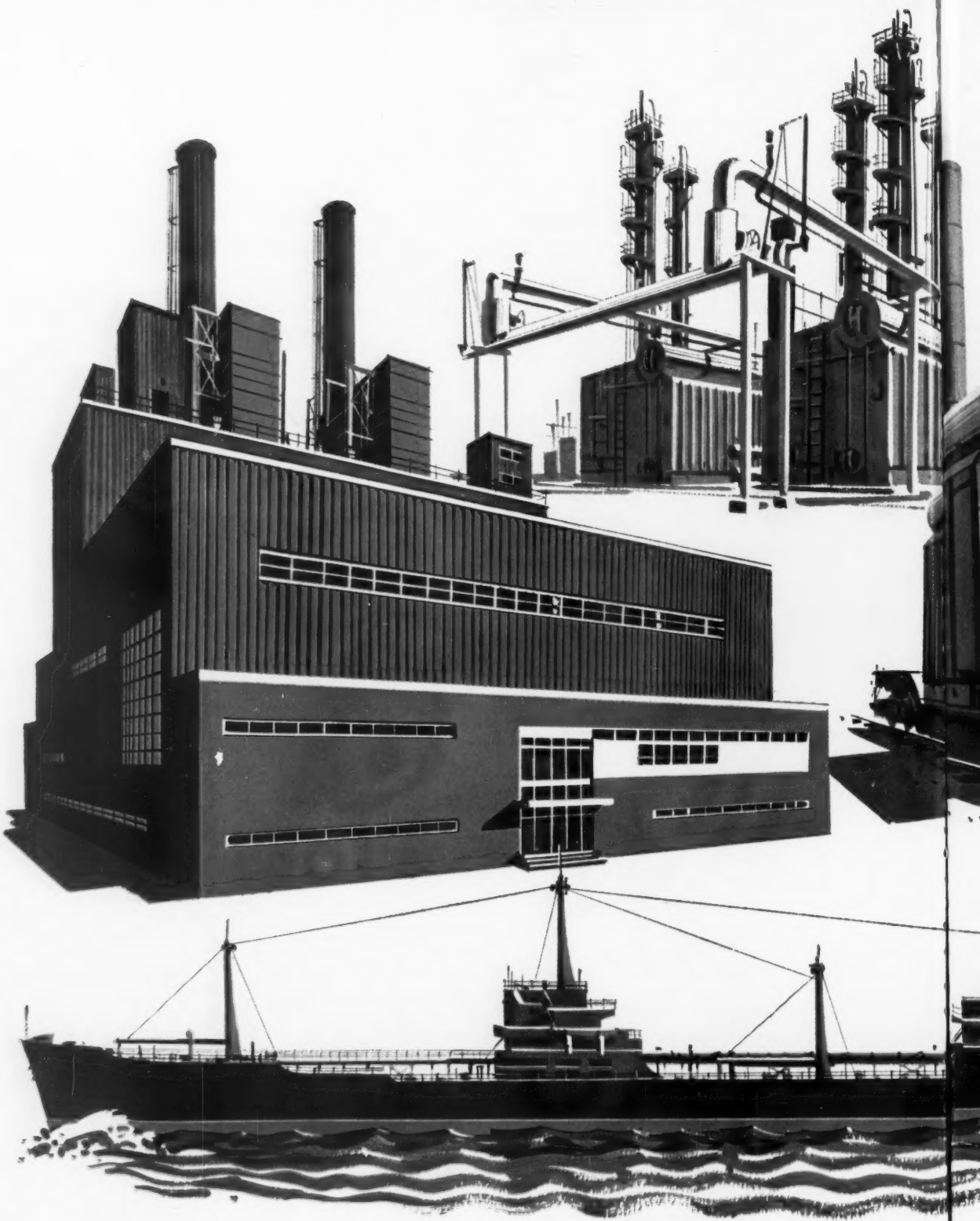
100 Mermaid Avenue, Philadelphia 18, Pa.

BRANCH OFFICES IN PRINCIPAL CITIES

YARWAY

A MARK OF QUALITY IN STEAM ENGINEERING

For more facts circle 209 on Reader Service card, p 103



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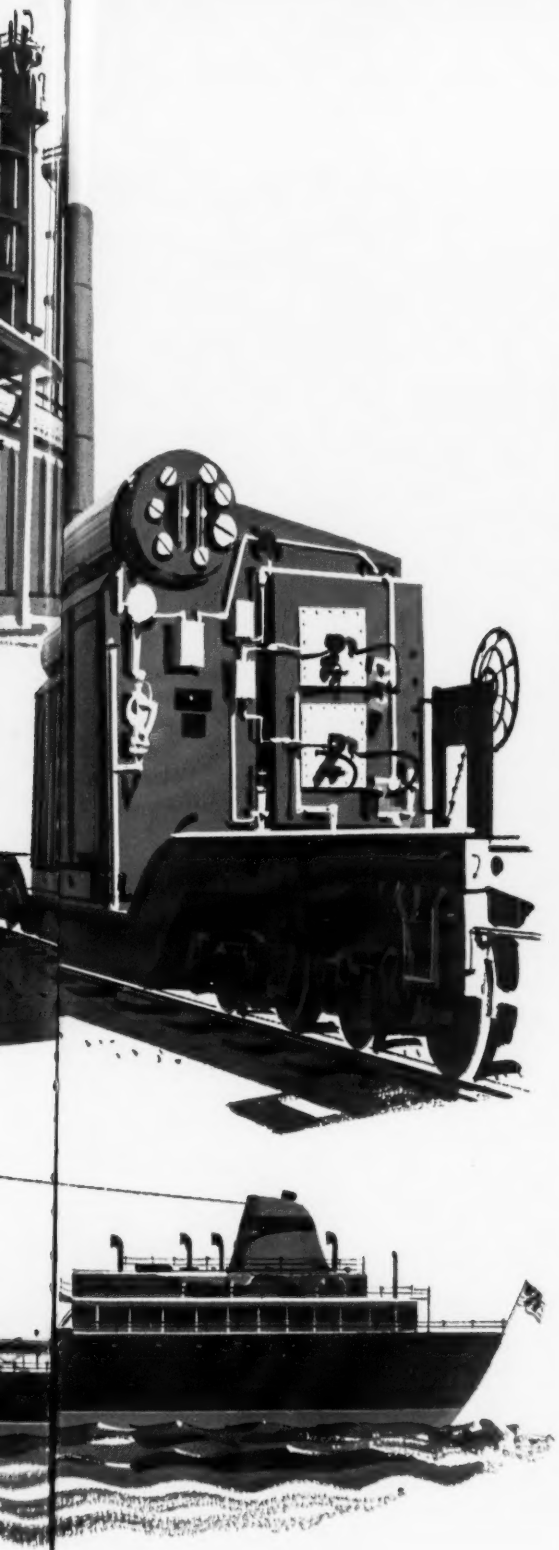

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FW engineers, fabricates and erects them all: utility and industrial steam generators, feedwater heaters, steam condensers, evaporators, pulverizers, cooling towers, specialized pressure vessels and industrial processing plants. Foster Wheeler Corporation, 666 Fifth Avenue, New York 19, N.Y.

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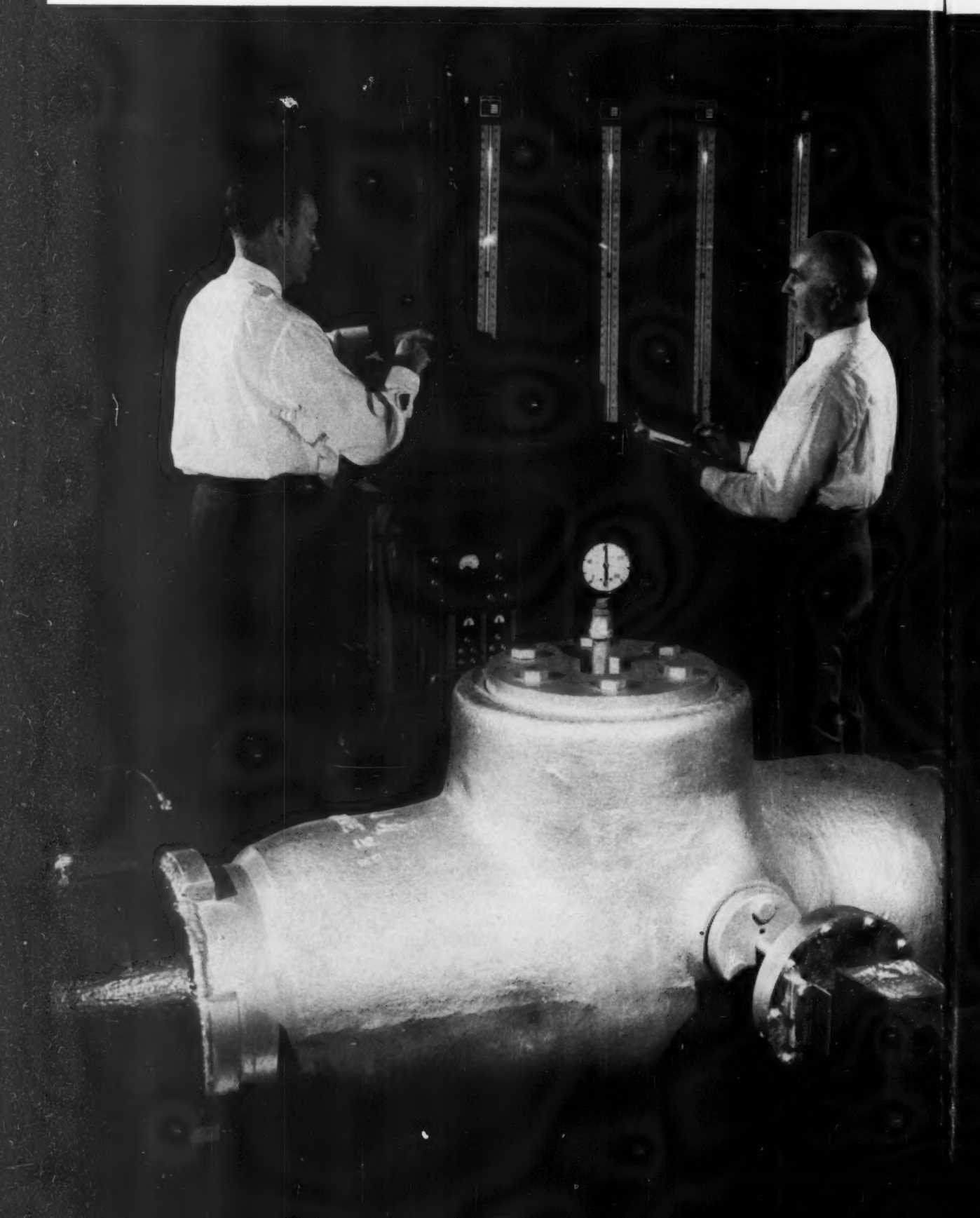
more facts circle 210 on Reader Service Card, p 103

Circle 211 on Reader Service card for following ad➤

The Story of Edward Research



n and the Foolproof Check Valve

The design of the Edward tilting disk check valve started with a single objective: one-piece body construction. Edward designers were convinced that they could achieve this essential objective and, at the same time, assure ease of inspection and maintenance after the valve was welded in the line. Ideally, the valve also had to have these four important operating features: 1) Tight seating; 2) Non-stick operation; 3) Quiet, slamless closing; 4) Low pressure drop. Six years of research and testing gave them these desired features, and made possible this Edward success story.

ONE-PIECE CONSTRUCTION

Both manufacturing and engineering considerations indicated the wisdom of a design with the seat at a right angle to the pipe line. It was also essential that gravity close the disk, whether the pipe was in a horizontal or vertical position. Edward engineers solved this dual problem by welding a counterweight to the disk so that the force of gravity would pull the disk down tight on the seat whether the valve was installed horizontally or vertically. With this new disk idea, the valve seat could be formed of a single circular weld deposit of Stellite, and could be machined and finished through the end of the valve. The resultant one-piece body is virtually impervious to leakage or distortion.

TIGHT SEATING

Getting the disk to seat tightly was especially important because even a small amount of reverse flow was a hazard to pumps and compressors. Edward designers, after experimenting with several pivot positions, pivoted the disk half-way between its center and the upper seating surface. The tapered Stellite-faced disk closes on a tapered Stellite seat in the manner of a globe stop valve. When flow reverses, the larger lower portion of the disk swings downstream while the smaller upper portion swings upstream. Utilizing both gravity and the force of reverse flow, perfect alignment and tight seating are achieved.

SLAMLESS, NON-STICK OPERATION

The unique Edward water flow test loop with its 2,000,000 lb per hour capacity closely simulates actual service conditions. Edward researchers could observe the effects of vibration and water hammer at all stages of tilting disk development. Designing the valve to close quickly—before reverse velocity could build up—virtually eliminated slamming and vibration. Three features make this possible.

First, the disk is dome-shaped to avoid the hesitation of motion characteristic of flat disks. Second, disk travel is minimized by pivoting the disk in the flow stream. Finally, torsion springs enclosed in the pivot pins accelerate closing action from the full-open position. The valve closes efficiently and achieves maximum opening even at lowest flow rates.

LOW PRESSURE DROP

Minimum flow resistance was achieved through painstaking design of all surfaces in the flow line. Full port seat design plus streamlined disk and location of the counterweight out of the flow stream resulted in minimum pressure drop.

A FOOLPROOF VALVE

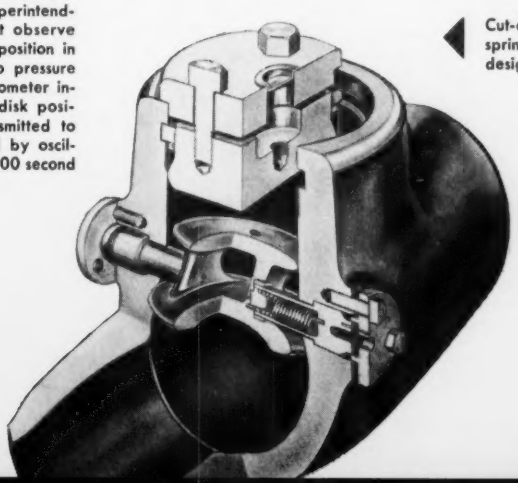
By tackling each problem separately—but always in relation to the entire design—Edward researchers came up with a tilting disk check valve that operated like no other check valve. It was dependable because it always functioned, effective because of its tight seating and low pressure drop, unique because it greatly minimized slamming, vibration, and water hammer.

This is the same tilting disk check valve, developed and patented by Edward Valves, that is so widely used in today's conventional, supercritical and nuclear power stations. Edward Catalog 14-Y gives full details.

Edward builds a complete line of forged and cast steel valves from ¼" to 24" for power, industrial, marine, and petroleum services. For more information, contact your Edward Representative, or write Edward Valves, Inc., 1230 West 145th Street, East Chicago, Indiana. Subsidiary of Rockwell Manufacturing Company. Represented in Canada by Lytle Engineering Specialties, Ltd., 438 St. Peter Street, Montreal. 6023

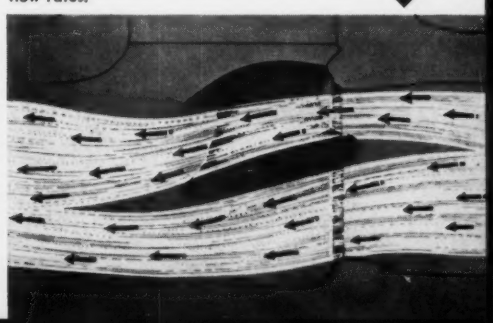
EDWARD STEEL VALVES
another fine product by
ROCKWELL

Director of Engineering and Research L. H. Carr and Plant Superintendent R. E. Rost observe test for disk position in relationship to pressure surge. Potentiometer indications of disk position are transmitted to and recorded by oscillograph in 1/100 second intervals.



Cut-away view of Edward tilting disk check valve shows torsion springs enclosed in pivot pins, pressure seal cover and other design features.

In the open position the disk rests against a stop, thus minimizing disk flutter. Careful design of disk facilitates maximum opening, even at extremely low flow rates.

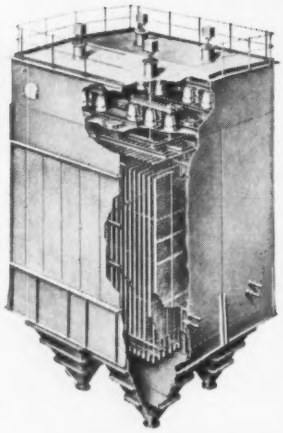


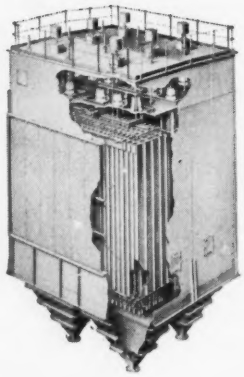
(Advertisement)

How to Evaluate Cottrell Precipitators

How Important Is Precipitator Size?

Traditional Design →





Modern Design ←

As shown in these two illustrations, Research-Cottrell's more compact modern design is appreciably smaller than the traditional design.

A common fallacy assumes a larger precipitator with lower gas velocity is preferable to a smaller precipitator with higher gas velocity.

This assumption overlooks important economies now obtained with:

(a) Efficient voltage application.

(b) Specific control of electrical sections.

(c) Electrode design improvements.

(d) Automatic Rapper Control.

(e) Accurate internal baffling.

(f) Proper control of gas flow, based on three-dimensional model studies.

Close familiarity with these techniques and improvements has made possible guarantees of 99 per cent collection on large, modern installations.

A. Applied Voltage

The relationship between voltage and size of the precipitator is approximately as shown in Figure 1.

Most efficient operation and minimum size are obtainable by insuring operation at maximum voltage under varying conditions of gas flow, particle size, resistivity, etc. Generally, the amount of arc-over in the precipitator will determine the practical operating voltage limit. By using the arc-over as the motivating control factor, through measurement and integration, maximum voltage can be insured at all times.

B. Sectional Voltage Control

Since gas conditions vary throughout any precipitator, higher efficiencies are obtainable if the precipitator is sectionalized with individual voltage control for each section.

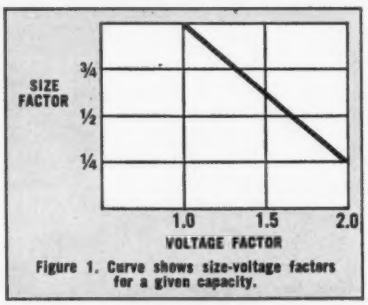


Figure 1. Curve shows size-voltage factors for a given capacity.

C. Electrode Design

Efficiency can be seriously affected by re-entrainment (that is the re-suspension of dust that has already been collected). Properly designed collecting electrodes, or plates, providing correct baffling to shield the collecting surface against the sweeping and scouring effects of the gas stream can reduce overall precipitator size 25–50 per cent.

D. Automatic Rapper Control

Rapping intensity must vary to meet the changing conditions of gas flow, particle size and resistivity. Otherwise, efficiency will decrease due to either too heavy a blow causing a re-entrainment, or too light a blow allowing dust build up on the electrodes necessitating operation at reduced voltages. Automatically controlled, fully adjustable rapping equipment insures optimum operation at all times.

E. Internal Baffling

Maximum efficiency can only be obtained by reducing the sneakage (part of gas stream which leaks or sneaks around the treatment zone) to an absolute minimum through the proper design and use of internal baffling proven by model studies and research on full size precipitators.

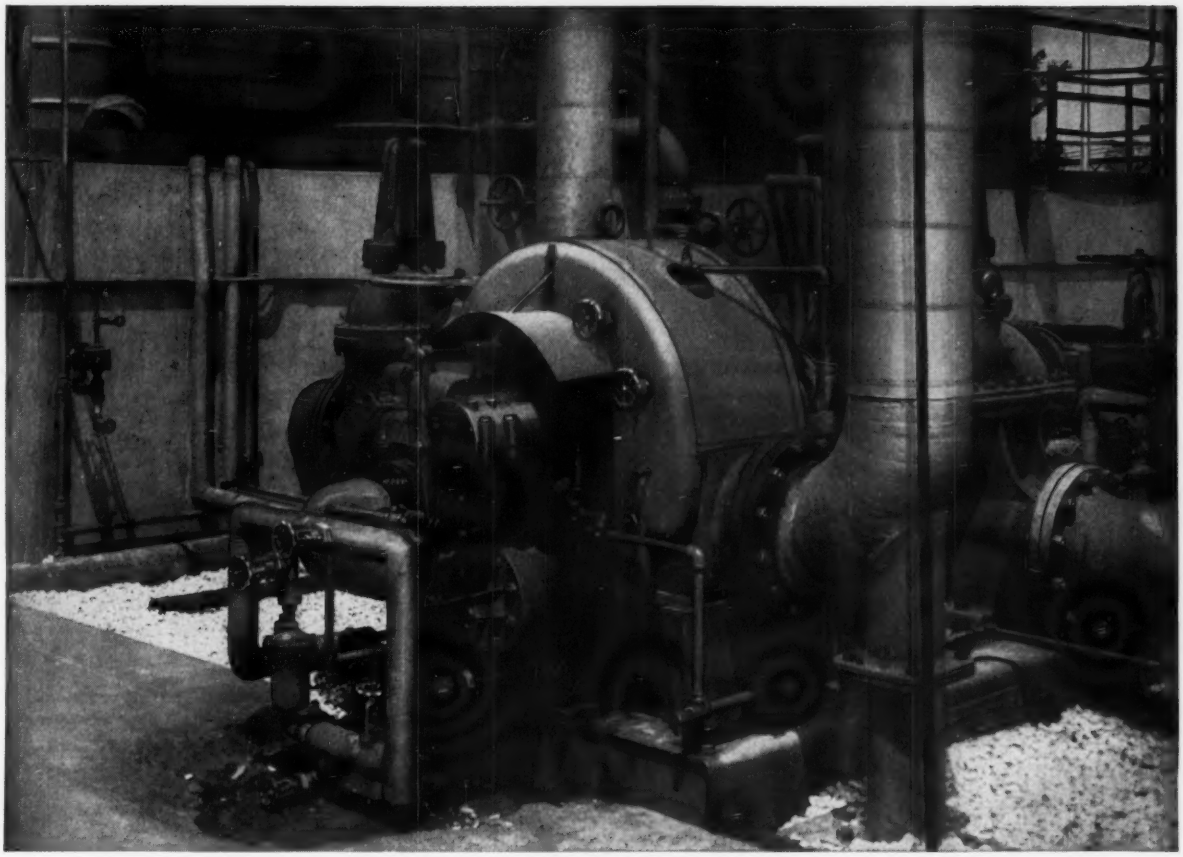
F. Gas Flow—Model Studies

Proper gas flow patterns across the face of the precipitator can result in a 25–50 per cent reduction in over-all size. The use of transparent plastic three-dimensional model studies as well as field research has resulted in refinements in design never before possible.

Only at Research-Cottrell can you be assured of these latest of design techniques and improvements providing the most economical selection of equipment and efficiency of operation. Research-Cottrell personnel, backed by nearly a half century of gas cleaning experience, stand ready at any time to provide information or service.

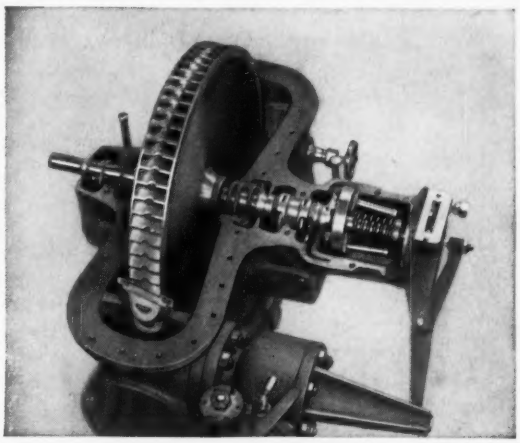
For details or more information relative to the data contained herein, or any other general inquiries, please contact your nearest Research-Cottrell representative or write directly to:

Research-Cottrell, Inc.
Office and Plant: Bound Brook, N. J.
Representatives in Principal Cities of U.S. and Canada. RC223



TERRY SOLID-WHEEL TURBINES

used exclusively at Baton Rouge plant of W.R.Grace & Co.



The upper photograph shows one of the 17 Terry turbines installed at the Baton Rouge, La., GREX high-density polyethylene plant of W. R. Grace & Co. Above, a typical Terry solid-wheel turbine with cover removed to show the wheel construction.

In purchasing equipment for their new 50,000,000-pound high-density polyethylene plant, W. R. Grace & Co. standardized, wherever possible, on a single source of supply for each type of equipment used. Consistent with this policy, Terry steam turbines were used exclusively throughout the utility and process sections of the plant.

A total of 17 turbines were placed in service for driving pumps and fans. These are all of the solid-wheel type, ranging in capacity from 50 to 240 HP.

Terry solid-wheel turbines are known for their long life and sure dependability under the most-trying operating conditions. They feature a single-piece wheel which is virtually indestructible.

Send for details of these trouble-free turbines. Ask for a copy of bulletin S-116.

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD 1, CONN.

TERRY

TT-1214

ENGINEERED GASKETS
for Plant Maintenance

Exacting control of gasket density is obtained by varying the number of metal plies and filler material to seal a specific pressure.

Controlled density is the reason why Garlock *Guardian Gaskets offer you unusual sealing ability.** A series of V-shaped metal plies alternated with layers of filler form the "body" of GUARDIAN spiral-wound gaskets. The proper selected thickness of filler material and preformed metal, the number of laminations of filler and metal and the correct tension of filler and metal while being formed into a gasket are factors engineered to achieve the proper gasket density.

This controlled density—combined with the special V-shaped metal plies—allows the gasket to "breathe." Thus, a tight seal is effected at all times despite equipment or line expansion and contraction. In no other type of gasket is it possible to vary the compressibility to meet different pressure and bolt load requirements.

Complete range of sizes, and shapes and wide temperature range is another reason for specifying Garlock GUARDIAN Gaskets . . . $\frac{1}{16}$" thickness up to 6", $\frac{1}{8}$" up to 30", .175" up to 60" and $\frac{1}{4}$" thick up to 60" depending on flange width. For temperatures up to + 1900° F. with ceramic filler material.

Type CR GUARDIAN Gaskets are furnished with a cadmium plated centering ring for corrosion resistance and prolonged shelf life. Centering ring also is marked with the pressure series —assuring application of correct gasket density for specific pressure.

Convenient local stocks of most standard sizes are maintained at Camden, New Jersey, Cleveland, Ohio, Houston, Texas and San Francisco. California, for quick delivery.

GARLOCK

Find out more from your Garlock representative at the nearest of the 26 Garlock sales offices throughout the U. S. and Canada, or write for catalog AD-176, Garlock Inc., Palmyra, N. Y.
Canadian Div.: Garlock of Canada Ltd.
Plastics Div.: United States Gasket Co.

Order from the Garlock 2,000... two thousand different styles of Packings, Gaskets, Seals, Molded and Extruded Rubber, Plastic Products.

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When it's time for replacement . . .

. . . more and more plants switch to OIC valves!

There's no magic to it! Engineers responsible for power and production look to OIC for longer continuous service and lower maintenance costs. These men have found by experience OIC iron and bronze valves (cast and forged steel and ductile iron too) are built to resist the three enemies of fluid handling . . . erosion, galling and corrosion. Trim variations are available to meet your specific requirements including special alloys for highly corrosive and severe pressure-temperature operating conditions.

OIC offers a complete line of gates, globes, angles and checks. Large stocks are carried throughout the United States by a fine distributor organization which stands ready to help you with all your valve problems. Our engineers are ready at a moment's notice to study particularly tough problems and submit recommendations. Get acquainted with your OIC distributor and learn how he can help you cut maintenance and replacement costs.

Better valves and better service from OIC distributors

INDUSTRIAL DISTRIBUTORS — SERVING INDUSTRY ECONOMICALLY — THE RIGHT HAND OF PRODUCTION

OIC VALVES

BRONZE, IRON, FORGED STEEL, CAST STEEL AND DUCTILE IRON VALVES

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Please send more information about Iron ( ) Bronze ( ) Steel ( ) Ductile Iron ( ) Valves.

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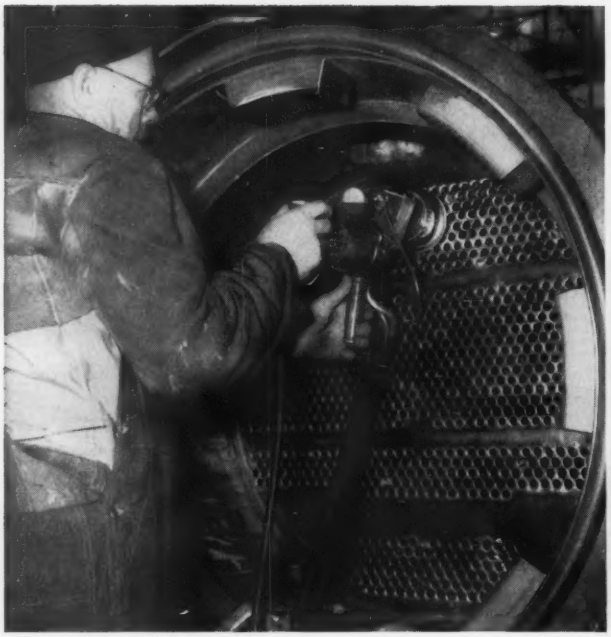
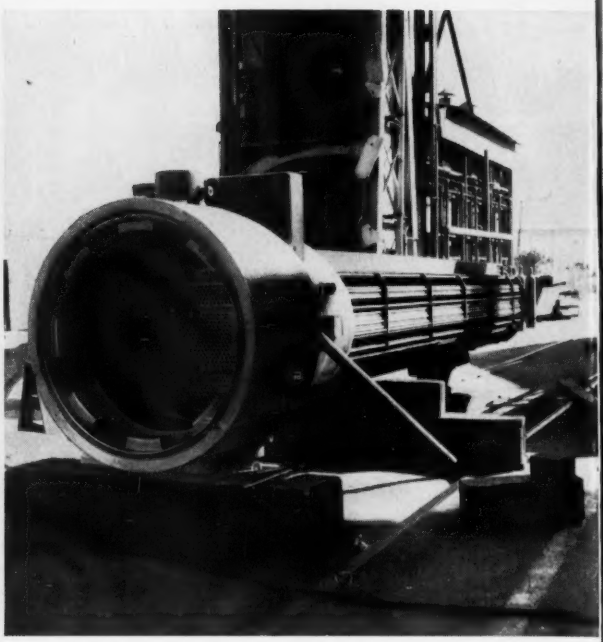


Using special type gun, average operator can make completely tight tube weld in less than 15 seconds.



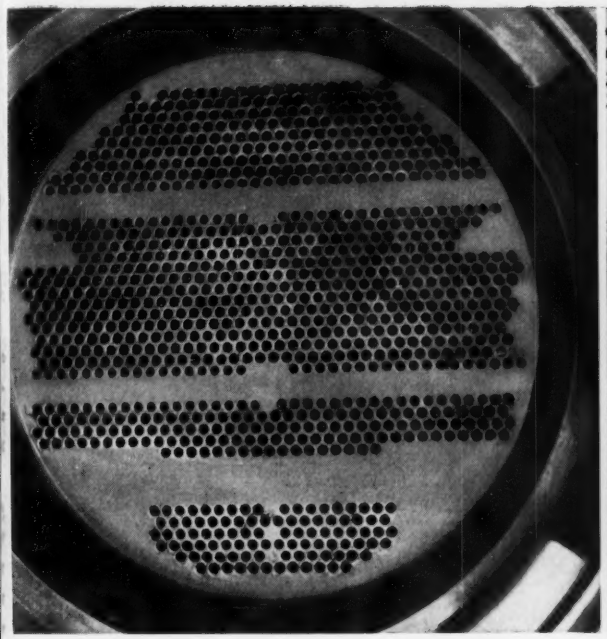
Head-on view of unit. Cufenloy-30 tubes are fabricated by special Phelps Dodge drawing and heat-treating process.

PHELPS DODGE CUFENLOY-30

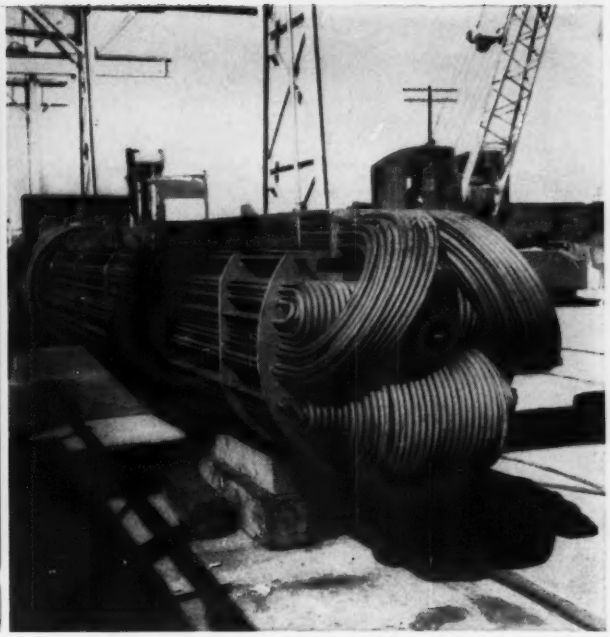
DUAL GAUGE TUBES WELDED INTO FEEDWATER HEATERS

U-bent units combine new high strength alloy tubes and new tube jointing technique for superior heat transfer efficiency and dependability

Photographs: Courtesy of Southwestern Engineering Co.



Close-up of tube sheet shows welded-in tubes in place. Incomplete or unsound welds are easily corrected by re-welding.



Rear view of high pressure feedwater heater unit shows configuration of Cufenloy-30, U-bent Dual Gauge tubing.

Dual Gauge tubes of Cufenloy-30, the new and weldable, drawn, stress-relieved copper nickel alloy developed by Phelps Dodge, have been welded into high pressure feedwater heaters constructed by Southwestern Engineering Co. for a West Coast utility.

Cufenloy-30, containing nominally 70% copper and 30% nickel, is approved under the ASME Code, Case No. 1266, for unfired pressure vessels. This new alloy offers improved properties for OEM and retubing at a lower cost per bundle, yet without sacrifice of safety when substituted for 65/35 nickel copper alloy tubes. The Dual Gauge process provides a heavier wall thickness to compensate for thinning on outer portions of return bends.

Specially designed Phelps Dodge welding guns were used to weld these tubes to the tube sheets. This advanced method assures tighter tube joints with more positive, permanent protection against leakage. The guns are controlled by preset relays and timers that start, stop and regulate electrode motion, welding current and argon flow.

Whatever your tubing or re-tubing requirements, call on Phelps Dodge for highest quality products, research and technical advisory service—a complete program backed by more than 40 years of experience in the heat exchanger and condenser tube field.

PHELPS DODGE COPPER PRODUCTS
CORPORATION
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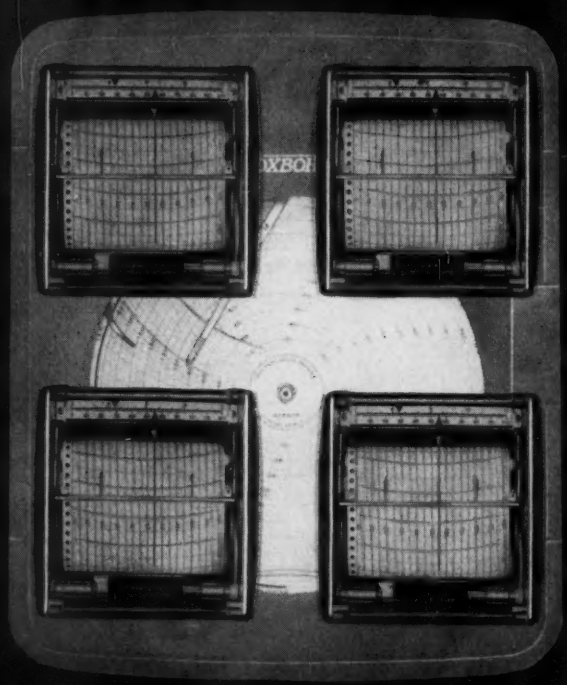
SAVE 75% OF YOUR PANEL SPACE without SACRIFICE OF FULL-SCALE RECORDS!



Foxboro CONSOTROL* Recorders

Yes, you can actually mount up to 4 Foxboro Consotrol Receiver-Recorders in the panel space ordinarily required for one conventional-size instrument — and get a full-scale, 4"-wide chart record from each one! Or, using 3-pen Consotrol Recorders, get a total of 12 full-size records in the same panel space!

This unique combination of compactness and high readability is in *addition* to the outstanding convenience Consotrol Recorders provide. They're by far the simplest to maintain . . . inking only once every 6 months; chart replacement every 30 days. And the chart loads quicker and easier than a box camera!

With Consotrol Recorders you can put records of *all* important trends on the board without crowding or limiting visibility. The same compact Consotrol design also is available with automatic control functions. Get full details on the complete modern Consotrol Line. Write for Bulletin 13-18. **The Foxboro Company, 684 Neponset Ave., Foxboro, Mass.**

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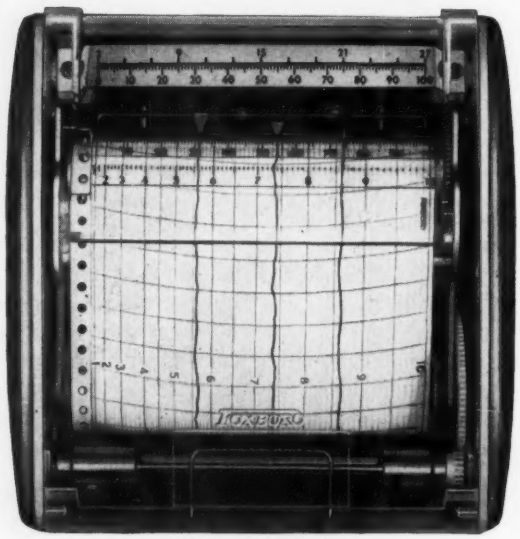

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Available in 3-27 psi or
3-15 psi air signal

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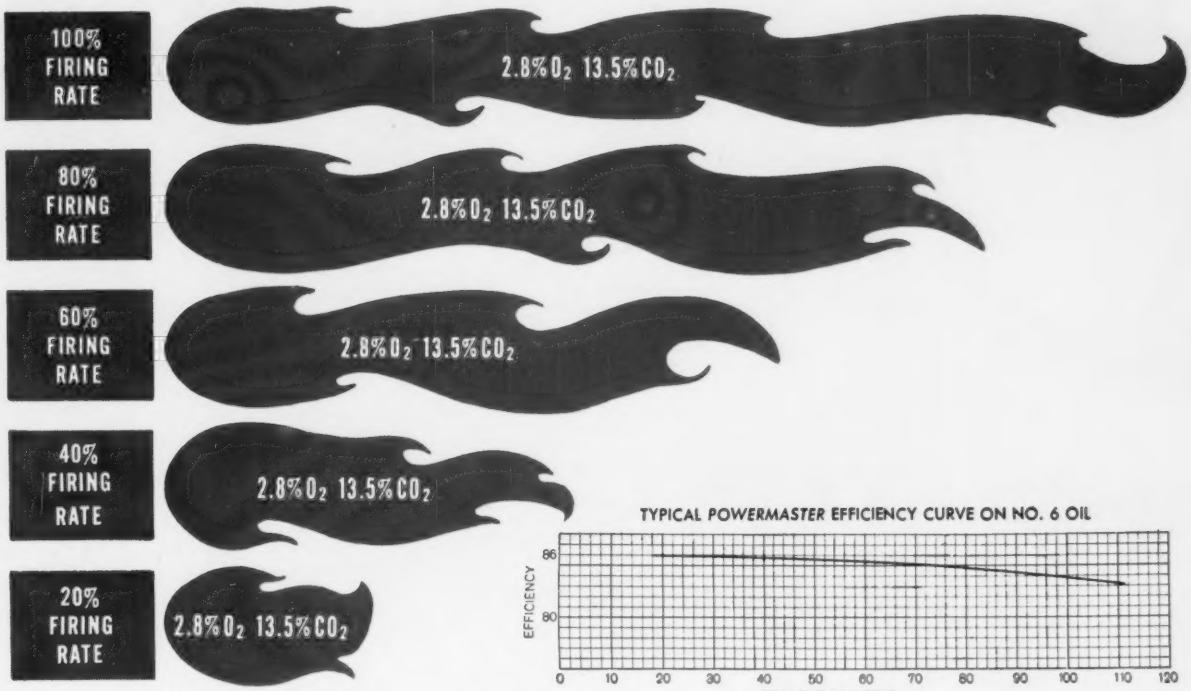
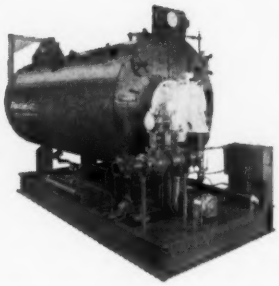
CONSOTROL PNEUMATIC INSTRUMENTS

FROM THE WORLD LEADER IN PACKAGED AUTOMATIC BOILERS AND BURNERS



Only *Powermaster*® gives you this type efficiency

Constant fuel-air ratio assures maximum efficiency at any load . . . cuts operating costs . . . returns investment faster



Whether you operate a *Powermaster* boiler from a low of 20% to a high of 100% of capacity, you get the same high constant efficiency. With O&S exclusive 5 to 1 turndown, fuel-air ratio is maintained at all loads with the same low percentage of excess air (2.8% O_2) and high percentage of CO_2 (13.5%).

This constant efficiency is important to you for three reasons: 1. Lower operating costs; 2. faster return on your investment; 3. more uniform heating, more uniform process and improved product quality.

Whether your requirements are for comfort heating, process or power, you'll pay for your boiler investment faster with an O&S *Powermaster*. For information on all *Powermaster* benefits, call your nearest O&S representative or write for Bulletin 1260.

75th Anniversary

ORR & SEMBOWER, INC.
850 Morgantown Road
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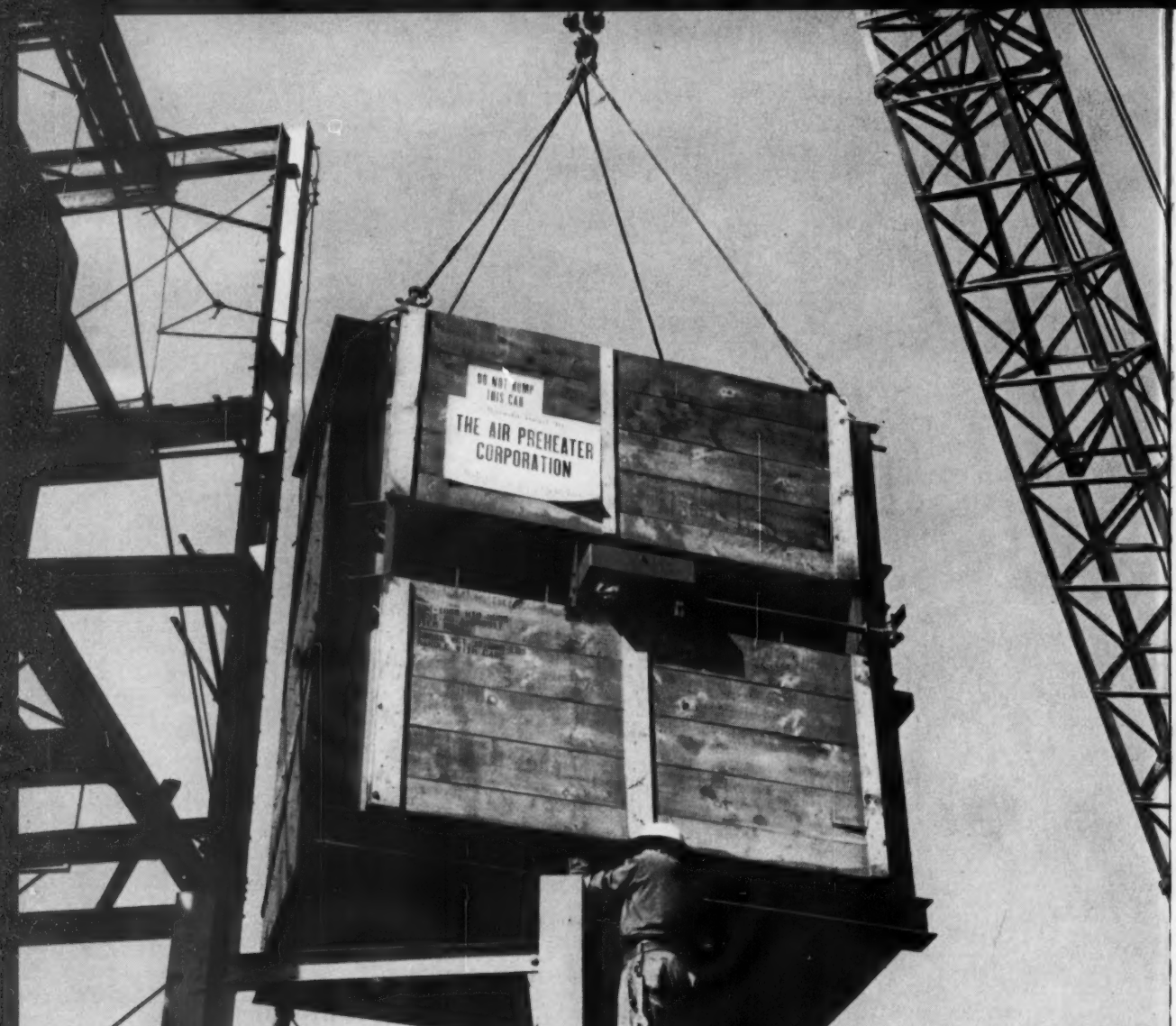
Powermaster®
PACKAGED AUTOMATIC BOILERS

For more facts circle 218 on Reader Service card, p 103



This compact Package Air Preheater is being installed on a 150,000 lb/hr boiler at Olin Mathieson Chemical Corp.'s Brandenburg, Kentucky, petrochemical plant. When in operation it will recover enough heat from the boiler exhaust to increase efficiency of the boiler between 8% and 9%.

OLIN MATHIESON RECOVERS 360°F FROM BOILER EXHAUST WITH 11½′ x 11′ x 8′ PREASSEMBLED LJUNGSTROM® PACKAGE AIR PREHEATER

Olin Mathieson specified a Ljungstrom Package Air Preheater because it saves space as well as fuel. Mathieson's Ljungstrom occupies only about 1000 cubic feet, but cuts boiler exhaust temperature from 680°F to 320°F — puts 360° of heat back to work in the boiler.

The compact preassembled Package Air Preheater is ready to run when it's delivered—just connect to the power line and ducts, and it's on-stream. You make big savings on installation because there's no on-the-spot erection.

You can use a Ljungstrom Package Air Preheater on boilers from 25,000 to 250,000 pounds of steam per hour. For more information, write today for your free copy of a 14-page booklet.

THE AIR PREHEATER CORPORATION

60 East 42nd Street, New York 17, N. Y.

For more facts circle 219 on Reader Service card, p 103

ANACONDA Announces

A new high-strength copper-nickel-iron tube alloy that makes possible substantial economies in feedwater heaters

Research metallurgists of Anaconda American Brass Company have developed, after three years of intensive effort, a new high-strength copper-nickel-iron alloy — Cupro Nickel, 30%-707—for heat exchanger tubes in power plant feedwater heaters.

Alloy 707 has mechanical properties comparable with those of a premium high-strength alloy now commonly used, and retains its strength at elevated temperatures—allowing working stresses up to 15,200 psi at 600° F. Thus, in an important area of high-temperature heater application it provides material-cost advantages.

And as these high mechanical properties are for the metal in the *annealed* condition, Alloy 707 tubes can be readily cold worked—can be expanded into tube sheets and formed into tight U-bends.

MECHANICAL PROPERTIES of Cupro Nickel, 30%-707 (nominal composition, copper 64.15%, nickel 30.00%, iron 5.25%, manganese 0.60%) are as follows:

Tensile Strength, min, psi	74,000
Yield Strength, (0.5% Extension under Load), min, psi	36,000
Elongation, % in 2", min	30
Expansion of Tube Inside Diameter with Tapered Pin, %, min	30

STRENGTH AT ELEVATED TEMPERATURES. Extensive tests at room and elevated temperatures show that design stresses given below can be used for Alloy 707:

Maximum Metal Temperature, °F	Maximum Allowable Stress Values in Tension, psi
100	18,300
150	17,800
200	17,500
250	17,100
300	16,800
350	16,400
400	16,100
450	15,900
500	15,600
550	15,400
600	15,200

WELDABILITY. Alloy 707 can be welded by the same methods used for regular 30% cupro nickel.

CORROSION RESISTANCE. Alloy 707 has the same high resistance to stress-corrosion cracking and the same excellent resistance to corrosion by salt water as regular 30% cupro nickel.

FOR MORE DETAILED INFORMATION on this new high-strength tube alloy, Cupro Nickel, 30%-707, see your Anaconda representative, or write: Anaconda American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont. 6160

ANACONDA®

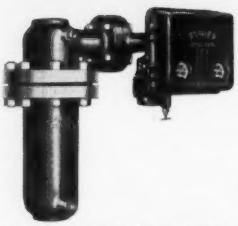
TUBES AND PLATES FOR CONDENSERS AND HEAT EXCHANGERS

Anaconda American Brass Company

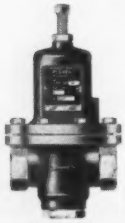
Need controls in a hurry?

Type 657
Control Valves

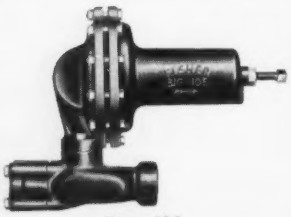
Type 4150 and 4160
Wizard II Pressure Controllers



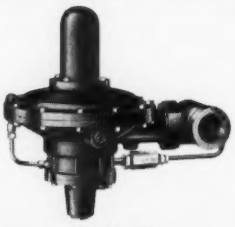
Series 2500–249 and 259B
Level-Trols—Cage Sizes 14" & 32"



Type 95
Pressure Reducing Valve



Type 630
"Big Joe" Field Regulator



Series 99
Multi-Purpose Gas Regulator

Call Fisher for 36-hour Service

For "supermarket" service write, wire, phone or TWX the factory or factory-trained engineers in these strategically located offices:

AMARILLO Vinson Supply Company
ATLANTA J. M. Smither & Company
BALTIMORE The Rhodes Controls Company
BIRMINGHAM Joseph W. Eshelman & Company
BOSTON Clarence B. Petty & Company
BUFFALO R. M. Newell Company
CALGARY-EDMONTON Barber Engineering & Supply Co.
CARACAS, VENEZUELA Sinclair Spence
CHARLOTTE Robert E. Mason & Company
CHICAGO General Meters & Controls Co.
CINCINNATI H. T. Porter Company
CLEVELAND A. E. Ehrke & Company
DALLAS Vinson Supply Company
DENVER Joy & Cox, Inc.
DETROIT DuBois-Webb Company
HOUSTON-CORPUS CHRISTI Puffer-Sweiven Company
INDIANAPOLIS Acme Engineering Agency
KANSAS CITY Sullivan-Mears Company
LOS ANGELES B. R. Jones & Company
LOUISVILLE Allan K. Cook Company
MARSHALLTOWN R. S. Stover Company
MEMPHIS Johnson & Scott
MEXICO, D. F. Babcock & Wilcox de Mexico
MILWAUKEE W. D. Ehrke & Company
MINNEAPOLIS R. G. Read & Company
MONTREAL Process & Steam Specialties, Inc.
NEW ORLEANS-LAFAYETTE John H. Carter Company
NEW YORK Crabbe & Stebbins Company
ODESSA-FARMINGTON Vinson Supply Company
PHILADELPHIA Clifford B. Ives & Company
PHOENIX Cone & Wallace Company
PITTSBURGH J. G. Chilcoat & Company
PORTLAND R. H. Brown & Company
RICHMOND D. W. Larcen & Company
ST. LOUIS H. D. Hale & Company
SALT LAKE CITY Williams, Gritton & Wilde
SAN FRANCISCO George R. Friederich & Company
SEATTLE Power & Controls, Inc.
SHREVEPORT John H. Carter Company
TORONTO Lantz Rhodes Ltd.
TULSA Vinson Supply Company
VANCOUVER Northern Columbia Process Equipment Company
WICHITA-LIBERAL Sullivan-Mears Company
WINNIPEG Mechanical Valve & Engr. Spec.

Offices listed in red maintain field stock.

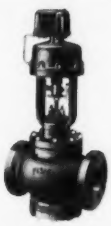
An Example of Fisher "Supermarket" Service . . .

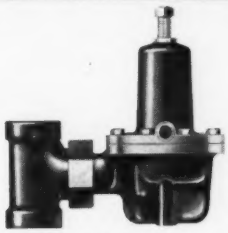
It was on a Friday morning when the Fisher representative in Oslo, Norway, called the plant in Marshalltown with an emergency order. Selection was made from the Fisher "Supermarket" stock and shipped immediately. The control was actually in the customer's plant in Oslo on the following Monday.

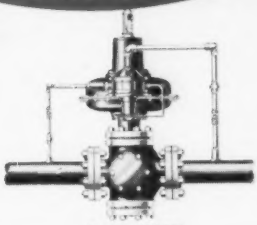
Fisher Governor Company, Marshalltown, Ia.
Plants in Woodstock, Ont., Rochester, England. Butterfly Valve Div.: Continental Equipment Co., Coraopolis, Pa.

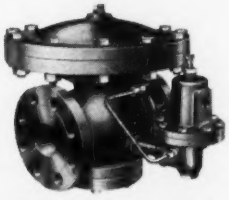
If it flows through pipe anywhere in the world ...chances are it's controlled by.....

FISHER® Controls SINCE 1880


Series 470
P.O.P. Control Valves

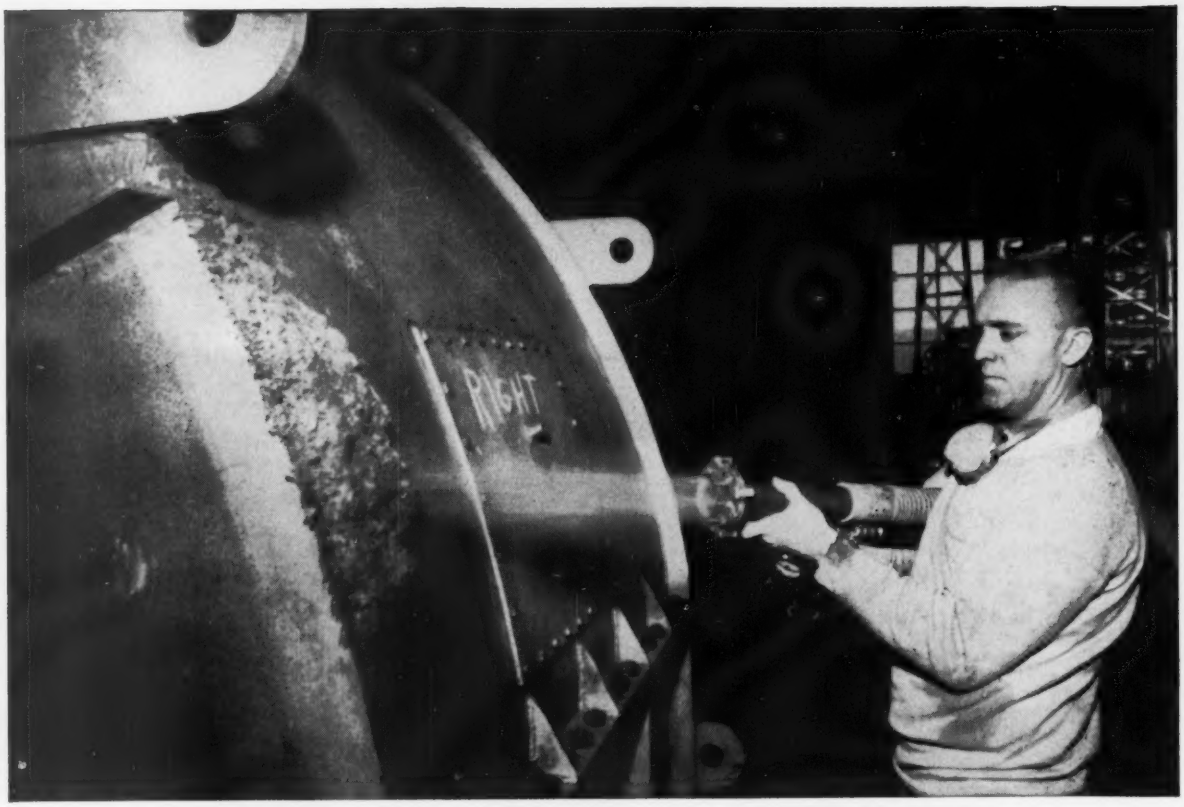

Series 620 and 621
Farm Tap Regulators


Series 298T
Gas Regulators


Type 92B Pilot Operated
Steam Reducing Valve

Type 655-A
Pressure Regulator

Series 67FR
Combination Filter Regulator



SPRAYED "LIMPET" ASBESTOS®
installs 25% faster than conventional thermal insulation

ON PHILADELPHIA ELECTRIC COMPANY GAS TURBINE

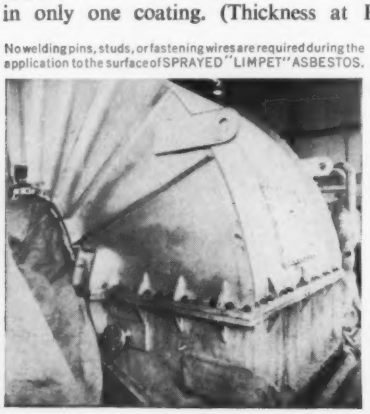
SPRAYED "LIMPET" ASBESTOS reduced labor costs, as well as installation time, at Philadelphia Electric Company's new gas turbine peaking installation on Barbadoes Island. The insulation contractor, Armstrong Contracting and Supply Corp., Philadelphia, Pa., applied this spray-shaped material to a 620 sq. ft. surface of a gas turbine exhaust fan housing in only ¾ of the time required by a conventional thermal-insulating material.

SPRAYED "LIMPET" ASBESTOS requires no mechanical supports during application. The easy, spray-gun method of application allows you up to 8″ thickness without reinforcing, in only one coating. (Thickness at Philadelphia Electric was 4″.) Soon after application, SPRAYED "LIMPET" ASBESTOS is ready for hard surfacing or weatherproofing.

This 100% asbestos insulation fits permanently, regardless of temperature changes. Withstands severe vibration, mechanical shock, frost, and Hot Face temperatures of up to 1350°F. Eliminates shakedown with time, flaking, shot fallout and deterioration.

In addition, SPRAYED "LIMPET" ASBESTOS does a number of other jobs at the same time: fire protection, noise reduction, condensation control, corrosion prevention, and dust exclusion. For more information, write to Keasbey & Mattison Company, Ambler, Pa., Dept. I-141.

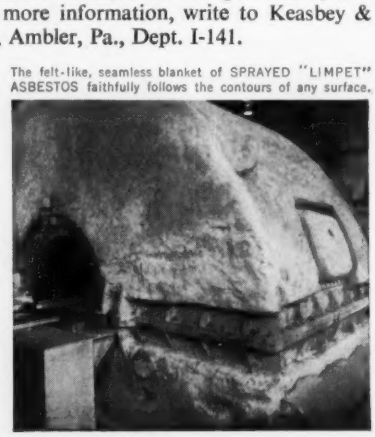
No welding pins, studs, or fastening wires are required during the application to the surface of SPRAYED "LIMPET" ASBESTOS.



K·M BEST IN ASBESTOS

Keasbey & Mattison at Ambler

The felt-like, seamless blanket of SPRAYED "LIMPET" ASBESTOS faithfully follows the contours of any surface.



For more facts circle 222 on Reader Service card, p 103

HOW DO YOU WELD STAINLESS?

WITH STICK ELECTRODES?...METAL ARC WELDING?...TUNGSTEN ARC WELDING?

(AIRCOMATIC®) (HELIWELD)

Airco supplies electrodes or wire for all three, gives you unbiased advice. Are the stainless steels that you weld light or heavy . . . martensitic, ferritic or austenitic . . . subject to heat, corrosion or stress? Whatever the application, Airco supplies electrodes or wire to weld them *better.*

For stick electrode welding: choose from 36 Airco Stainless Electrode types. They give you high welding speed with low heat input. Welds are smooth, spatter is minimal, cleaning and polishing are easy.

For inert gas shielded processes: depending on application, you'll choose either AIRCOMATIC® gas shielded metal arc welding – or Airco's HELIWELD gas shielded tungsten arc welding. For both of these processes, Airco Stainless steel welding or filler wire gives excellent corrosion resistance and excellent tensile, ductility and impact properties.

Which is best for you? Call Airco for an unbiased answer – for only Airco makes equipment for all three processes. Look in Classified Telephone Directory under "Welding Equipment and Supplies" for your nearest Authorized Airco Distributor. Write today for a copy of Airco's "Electrode Pocket Guide" and "Aircomatic Welding Wire Pocket Guide."

AIRCO

electrodes stay factory-fresh and dry to the very last electrode – protective "POP" can is resealable!

AIRCO

AIR REDUCTION SALES COMPANY

A division of Air Reduction Company, Incorporated

150 East 42nd Street, New York 17, N. Y.

More than 700 Authorized Airco Distributors Coast to Coast

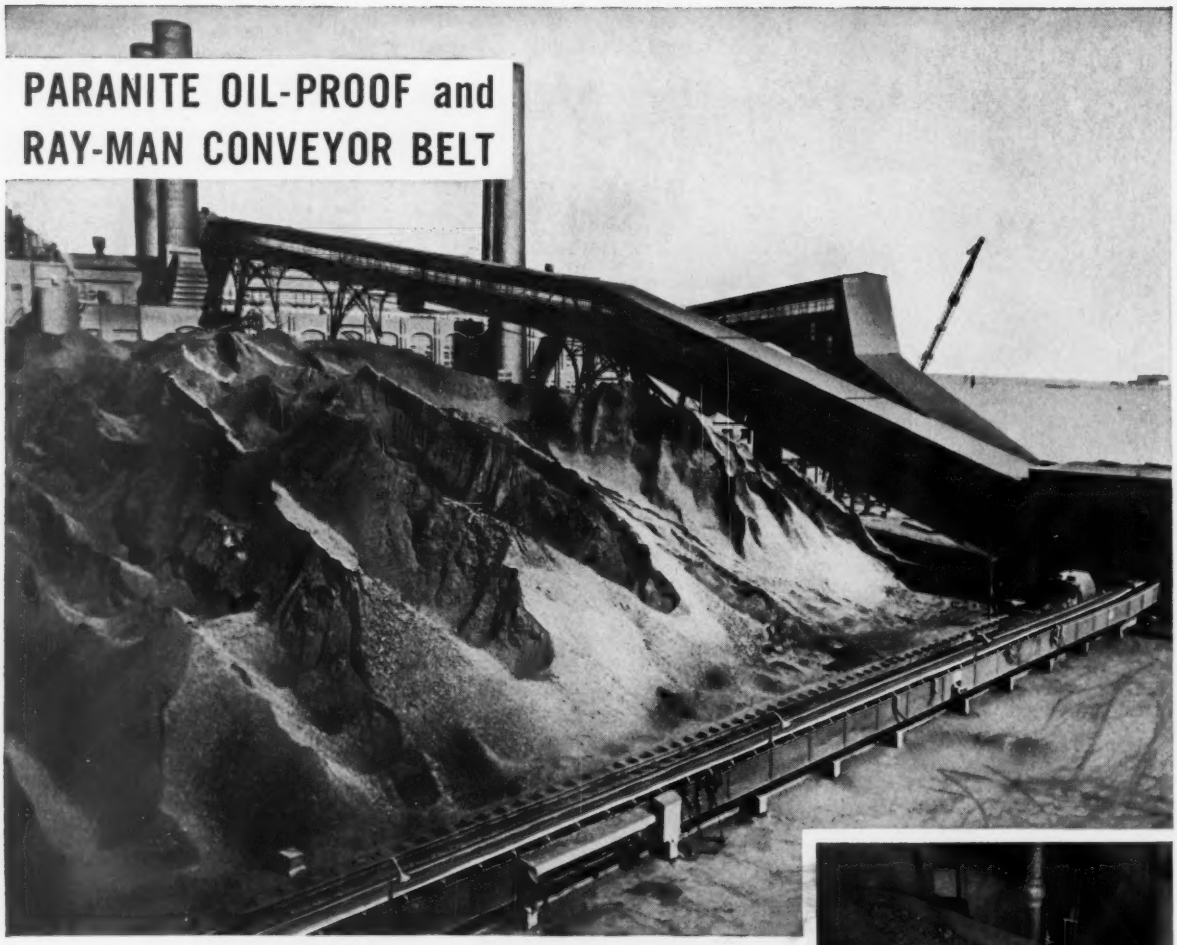
On the west coast– Air Reduction Pacific Company

Internationally– Airco Company International

In Canada– Air Reduction Canada Limited

All divisions or subsidiaries of Air Reduction Company, Inc.

For more facts circle 223 on Reader Service card, p 103



Over 20 Years' Uninterrupted Service At A Major New England Power Plant

The year: 1940. The requirement: 4,000 feet of conveyor belt to carry oil-treated coal from stockpile to boiler plant at a large electric light and power plant. This meant a "new" oil-proof conveyor belt able to withstand oil emulsion without swelling and causing excessive spillage. The recommendation: Manhattan's Paranite Oil-Proof Conveyor Belt with neoprene cover, one of the first all-synthetic rubber belts made for handling oil-sprayed coal and coke. Result: The Paranite Belt installation did the job . . . and continues to do the job today after twenty years of trouble-free service!

RAY-MAN BELT

Where oil is not a problem, Ray-Man Conveyor Belt will outperform all others. Precision proportioned for perfect balance. Double compensation relieves outer ply stress at bends. Trains naturally, holds fasteners better, resists impact and ripping, requires no breaker ply. Exclusive "XDC" cover for much longer wear. Troughs deeply for 45° idler operation to increase load capacity up to 60%. See your R/M Distributor or write for Conveyor Belt Catalog 25 CB.

CLOSE-UP VIEW OF PART OF 4,000 FOOT PARANITE CONVEYOR BELT. NOTE CONDITION OF BELT AS IT FLEXES OVER PULLEY. TWENTY-YEAR-OLD INSTALLATION IS THE LARGEST OF ITS KIND.

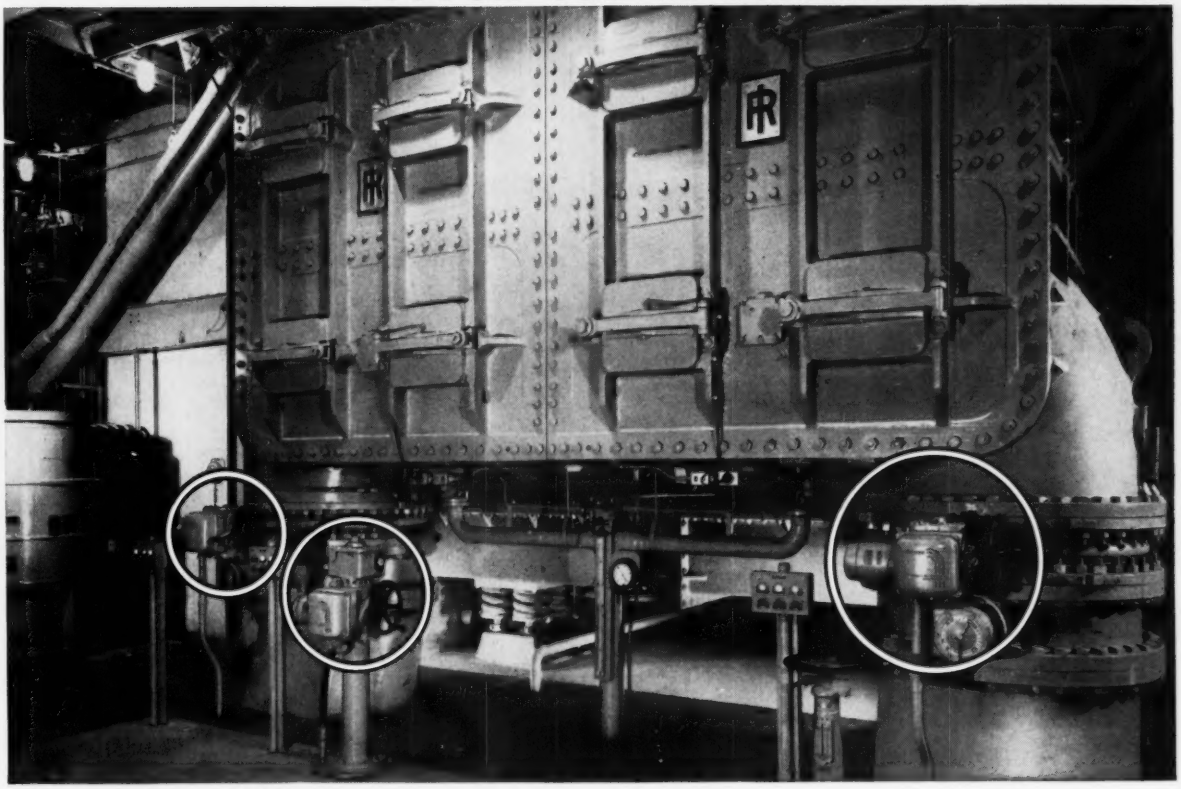
RM 115

RAYBESTOS-MANHATTAN, INC.
MANHATTAN RUBBER DIVISION • PASSAIC, N. J.
ENGINEERED RUBBER PRODUCTS

For more facts circle 224 on Reader Service card, p 103

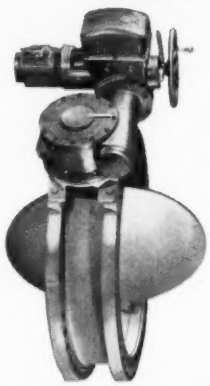
LimiTorque

...FOR USE IN CONDENSER SERVICE



...on Three IR Rectangular Condensers

...in large West Coast Steam Plant



Send for Bulletin #15-60, and please use your Business Letterhead when requesting a copy.

Above is shown one of the three Ingersoll-Rand space-saving Rectangular Condensers which serve the three 100,000 k.w. Generating Units in a large, well-known West Coast Steam Plant. Each Condenser contains 50,000 square feet of surface. Six I-R vertical pumps push nearly 270,000 gallons of cooling water per minute through the LimiTorque operated Butterfly Valves and the condenser tubes. The condensate is handled by six other I-R vertical pumps.

It is highly significant that LimiTorque Valve Operators are used in practically every Central Station and Large Industrial Power Plant built during the last twenty-five years—because of their absolute accuracy and reliability.

Where automatic, remote Valve Operation is required, LimiTorque will provide rapid, precise, safe and dependable control, under all operating conditions . . . and, remember too, LimiTorque can be field-mounted on most all existing valves. For specific applications, consult your Valve Manufacturer or nearest LimiTorque Sales-Engineering Office.

THERE IS NO SUBSTITUTE FOR —

LimiTorque®

PHILADELPHIA GEAR CORPORATION

KING OF PRUSSIA (SUBURBAN PHILADELPHIA), PA.

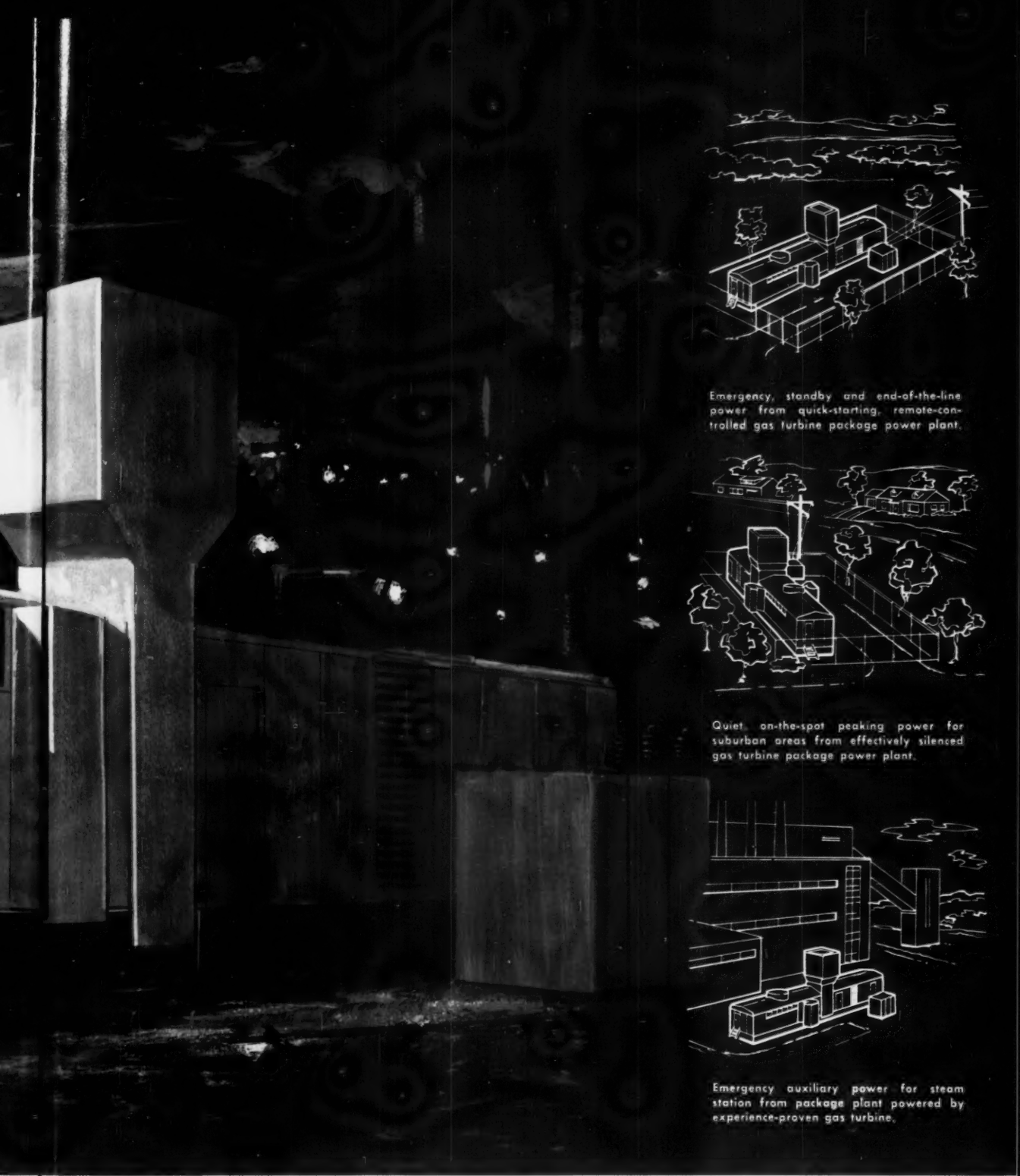
Offices in all Principal Cities

INDUSTRIAL GEARS & SPEED REDUCERS • LIMITORQUE VALVE CONTROLS • FLUID AGITATORS • FLEXIBLE COUPLINGS

Limitorque Corporation • King of Prussia, Penna.

NEW... General Electric Package Power Plant Offers...

$85/kw multi-purpose power generation with proven gas turbine



Emergency, standby and end-of-the-line power from quick-starting, remote-controlled gas turbine package power plant.

Quiet, on-the-spot peaking power for suburban areas from effectively silenced gas turbine package power plant.

Emergency auxiliary power for steam station from package plant powered by experience-proven gas turbine.

Complete, self-contained, compact power plant — and it's available for operation on your system this year. The plant supplies dependable turbine power, 11,250 kilowatts*, for a variety of short-duration loads.

Package design offers significant manpower and maintenance economies, maximum site selection flexibility, and $85/kw low initial cost. G-E gas turbine reliability is backed by over five million hours of rugged operation — peaking and base-load utility service, continuous duty in process plant drives, start-stop service in locomotives, and base-load power for pipe-line pumping.

For more information on this new concept in power generation, contact your G-E Generation Sales Engineer or write for Bulletin GED-4217, General Electric Co., Section 247-44, Schenectady 5, N. Y.

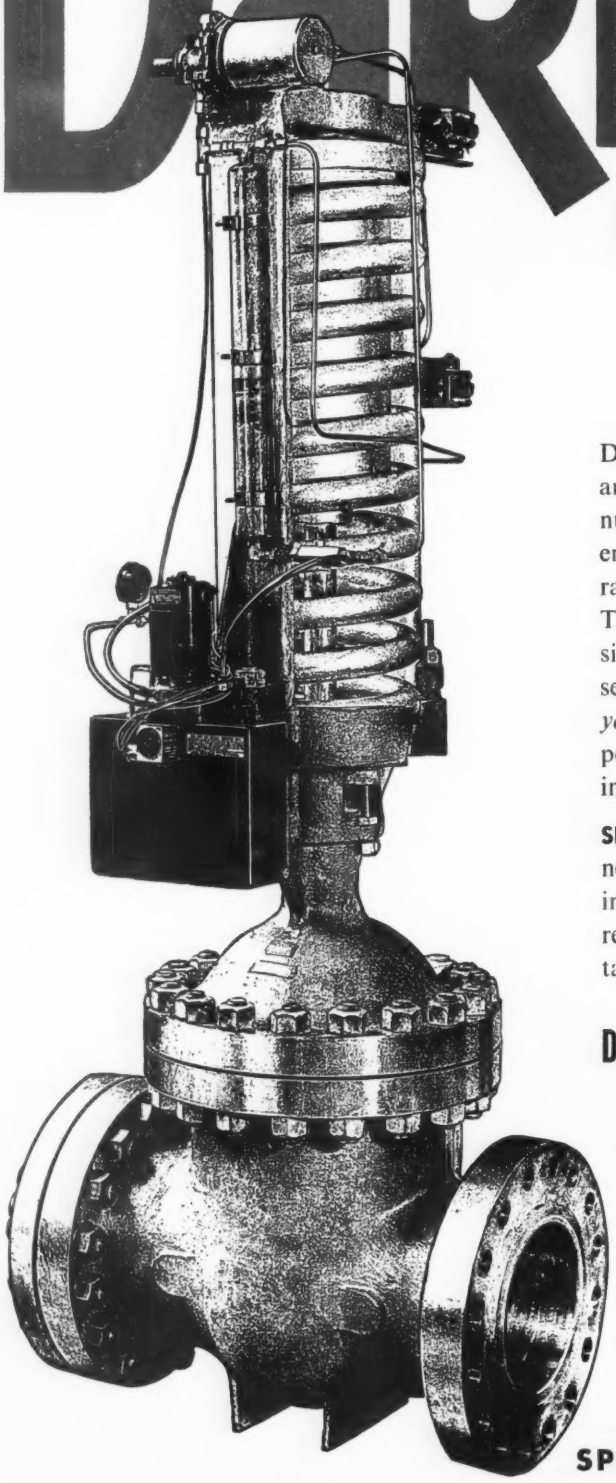
* Peaking capacity at 80F, 1000-ft. altitude.

Progress Is Our Most Important Product

GENERAL ELECTRIC

YOU CAN DEPEND ON

Darling



Darling special stainless steel gate valves are meeting the most precise demands of nuclear services. They are used in power generation installations and for flow control of radioactive fluids.

These special-purpose valves have the exclusive benefit of our revolving double disc parallel seat wedge construction feature. That's why *you can depend on Darling* steel gate valves for positive sealing and continuous ease of opening and closing.

SPECIAL ENGINEERING SERVICE. Darling engineers are ready to work with you in designing special valves to meet unusual service requirements. Write, wire or phone for detailed information.

DARLING VALVE & MANUFACTURING CO.

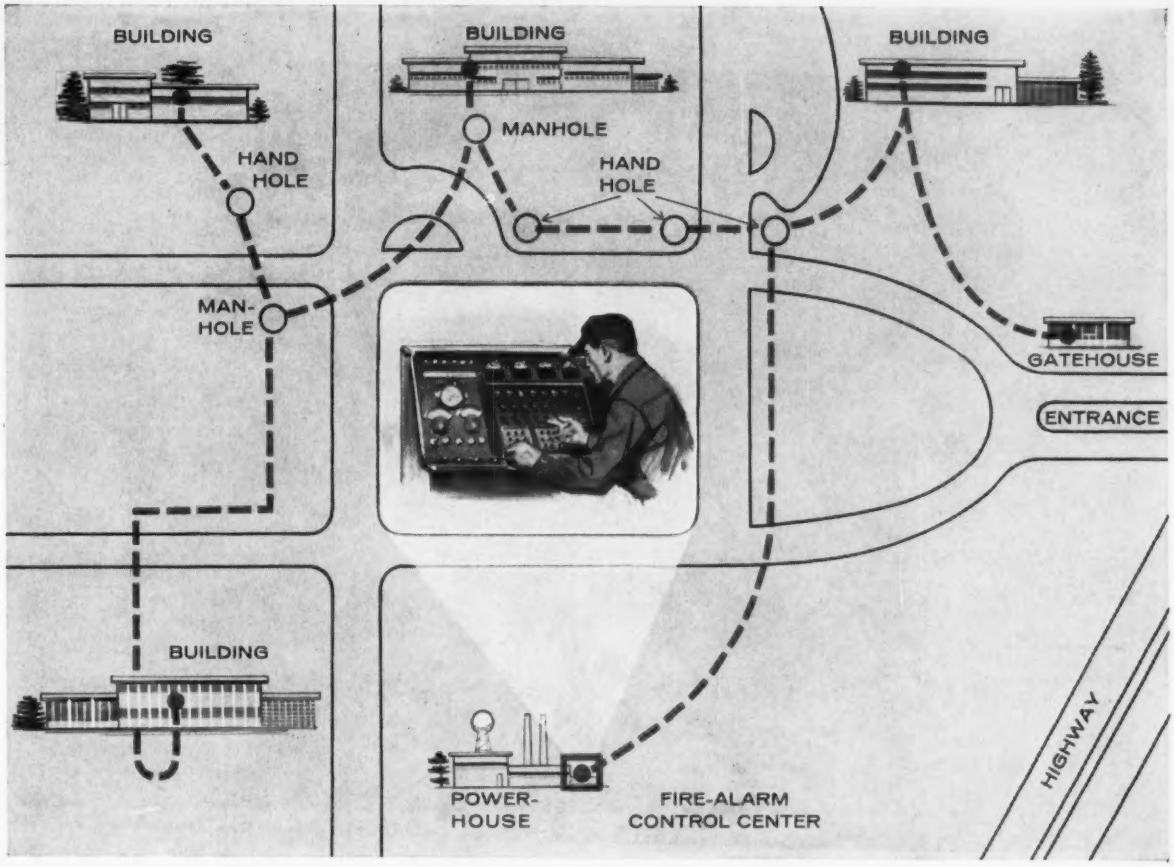
Williamsport 8, Pa.

Sandilands Valve Manufacturing Company, Ltd., Galt 19, Ontario, Canada.
Vannes Darling-France, 23 rue du Commandant Mouchotte, St. Mandé, France.

TRADE DARLING MARK

GATE • BUTTERFLY • CHECK
SPECIAL VALVES • FIRE HYDRANTS

For more facts circle 227 on Reader Service card, p 103



IN THIS PLANT'S FIRE-ALARM SYSTEM...

Cable made with TEFLON® eliminates cause of failure...costly maintenance

The control cables of a fire-alarm system linking several buildings of a manufacturing plant (shown above) are now made with primary insulation and jacketing of Du Pont TEFLON 100 FEP resin. *There are good reasons why.* The jacketing previously used had been attacked by heat and moisture from a steam line adjacent to one of the underground conduits. By-products of the deteriorated jacketing attacked shielding and primary insulation. The cable shorted out . . . the alarm system became inoperative . . . a costly and time-consuming repair problem arose.

The new cable provides unequalled reliability for this vital alarm system, and minimizes costly maintenance in future years. TEFLON FEP resins are rated for continuous use up to 400°F., and are completely resistant to moisture, aging, and virtually all chemicals and corrosives.

New, melt-processible FEP resins now make available to industry the long life and extra reliability of TEFLON resins in the form of extruded jacketing and long lengths of wire insulation. In addition, the use of insulation of FEP resins permits miniaturization of cables—you can get twice as many conductors, twice as much power, twice as much control in each conduit.

Whatever the service conditions encountered by cables in *your* operation, it will pay you to consider the long-term economies, the extra safety and reliability made possible by TEFLON resins. Consult your supplier for more information, or write to: E. I. du Pont de Nemours & Co. (Inc.), **Dept. P-4**, Room 2507T, Nemours Bldg., Wilmington 98, Del. *In Canada:* Du Pont of Canada Limited, P.O. Box 660, Montreal, Quebec.

DU PONT
REG. U.S. PAT. OFF.

TEFLON®
FLUOROCARBON RESINS

TEFLON is Du Pont's registered trademark for its family of fluorocarbon resins, including TFE (tetrafluoroethylene) resins and FEP (fluorinated ethylene propylene) resins.

BETTER THINGS FOR BETTER LIVING...*THROUGH CHEMISTRY*

For more facts circle 228 on Reader Service card, p 103

Compact
Close-coupled air motor combines minimum space, maximum efficiency.
Rugged
Steel and aluminum motor cases provide high strength.
Adaptability
Available for pneumatic or hydraulic operation in various pressure ranges.
Low Maintenance
Diaphragms and "O" rings are the only parts that normally need replacement.
Economy
Selection of five motor sizes for minimum first cost.
Minimum Number of Working Parts
All are enclosed and protected.

Why this power-operated diaphragm valve is so versatile... economical

The Grinnell double-acting air motor teams up with the Grinnell-Saunders Diaphragm Valve to provide a power-operated valve that's versatile and economical! What's more, the "Grinnell" name on each part assures you of the highest quality throughout the completed unit. Available in a range of motor sizes for ½" through 6" valves. Learn how Grinnell power-operated valves can help *your* installation. Write Grinnell Company, Providence 1, R. I.

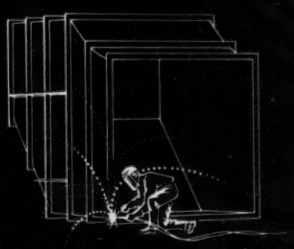
You get a wide choice of accessories too!

- Handwheel closing device
- Positioner
- Adjustable travel stop
- Adjustable opening stop
- Position indicator
- Microswitches

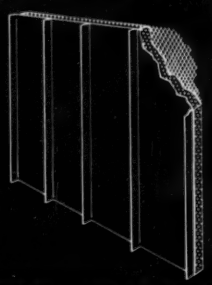
GRINNELL-SAUNDERS DIAPHRAGM VALVES

GRINNELL COMPANY, PROVIDENCE 1, R. I. • BRANCH WAREHOUSES AND DISTRIBUTORS FROM COAST TO COAST
PIPE FITTINGS • VALVES • PIPE HANGERS • PREFABRICATED PIPING • UNIT HEATERS • PIPING SPECIALTIES

For more facts circle 229 on Reader Service card, p 103

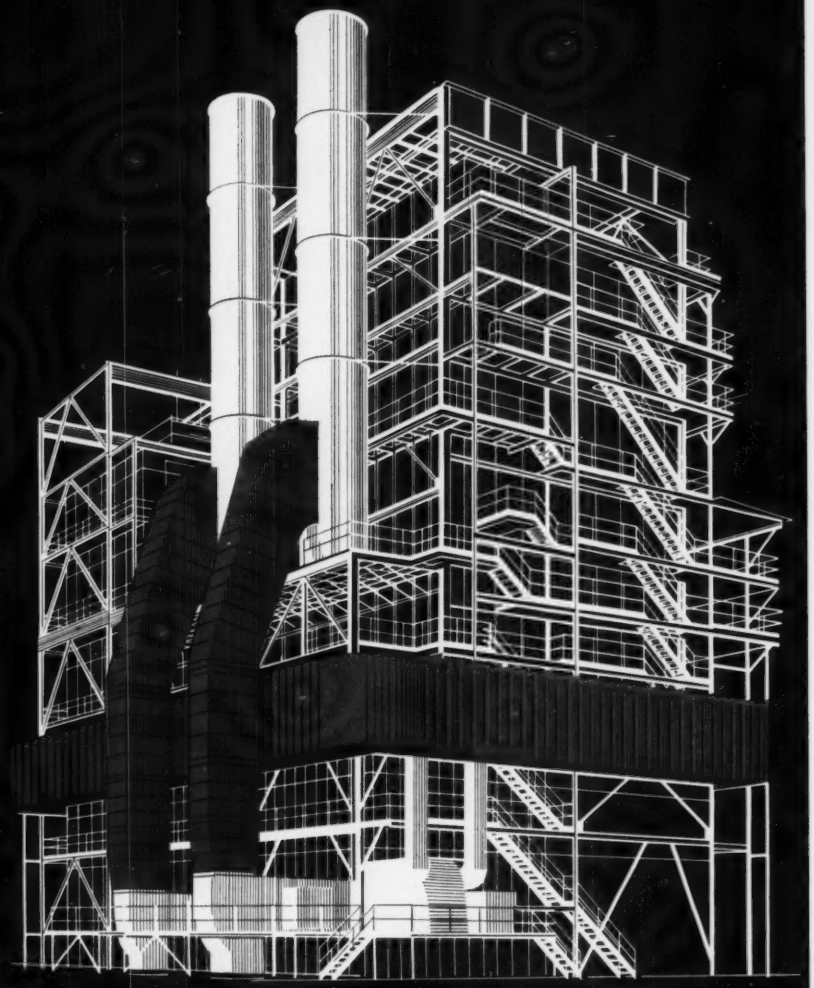


Breeching panels are factory prefabricated and/or pre-insulated; match-marked for shipment.



DeVilbiss combines insulation and lagging into a prefabricated panel, reducing insulation costs.

Experienced DeVilbiss crews are available to handle complete job-site assembly and erection.



pre-insulated breeching is a new concept pioneered by DeVilbiss' Metal Fabricators Division. It means prefabricating lagging and insulation in a single operation at the factory. Benefits to you: substantial reduction of field-insulation costs, reduced corrosion, increased thermal efficiency. Specialists work with you, from blueprint detailing to erection in your plant.

Talk to DeVilbiss about all your power-plant breeching requirements

FOR TOTAL SERVICE, CALL
DEVILBISS

THE DeVILBISS COMPANY, Toledo 1, Ohio. Also Barrie, Ontario; London, England; São Paulo, Brazil. Branch offices in principal cities.

For more facts circle 230 on Reader Service card, p 103

Complete responsibility centered in one specialized organization!

Undivided responsibility for *all* phases of a temperature control installation — from coordinated planning to future service — is the key to lasting owner satisfaction. Each Johnson System, small or large, is furnished on this basis, for 75 years' experience has proved it to be the *only* way to assure the kind of lifetime efficiency and operational economy you expect from your control system.

When you invest in a Johnson Pneumatic Control System you are investing in years of reliable performance, something hardly to be expected from scattered sources whose responsibility ends with the sale. With air conditioning, heating, and ventilating systems becoming increasingly complex, now it is even more important that responsibility for your control system be centered in one organization.

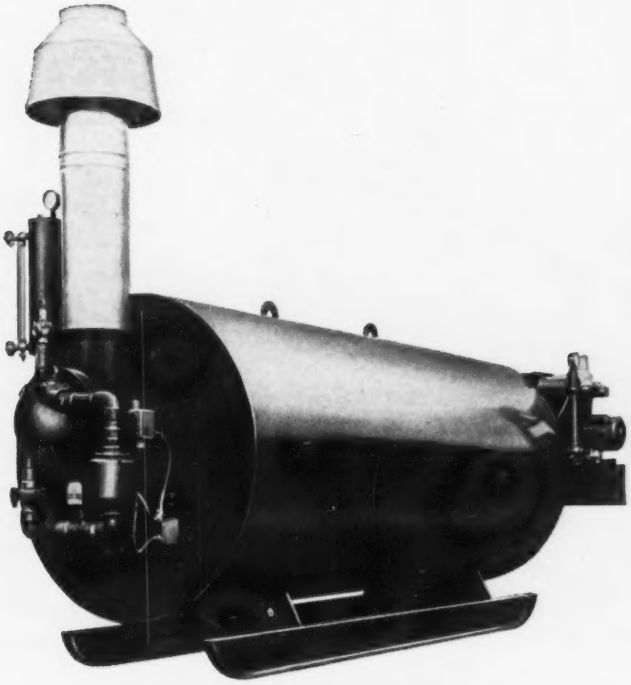
Johnson's way of doing business, as demonstrated in leading buildings everywhere, enables you to enjoy the very finest standards of indoor climate control at the lowest possible lifetime cost. When you build or air condition, ask your consulting engineer, architect, or local Johnson engineer for the facts about Johnson Control. Johnson Service Company, Milwaukee 1, Wisconsin. 105 Direct Branch Offices.

JOHNSON CONTROL

PNEUMATIC SYSTEMS

DESIGN • MANUFACTURE • INSTALLATION • SINCE 1885

For more facts circle 231 on Reader Service card, p 103



p-k scalefree 230*

first indirect gas fired storage water heater

provides lots of hot water...fast

for Hitchins, Ky., General Refractories Co. Plant

GENERAL REFRACTORIES COMPANY

A million-dollar expansion at the Hitchins, Ky., plant of the General Refractories Co. required a 40% increase in employees – and more hot water.

Following a survey of available heaters, the company decided on the SCALEFREE 230 because of its exclusive thermal design principle. The new heater employs three basic systems: the gas-burning system – the furnace part of the unit; a forced circulation transfer fluid system; and the service water system, which provides for storage, heating and temperature control. Since heat transfer occurs below the temperature at which the minerals that cause scaling precipitate, the unit retains its initial rated efficiency.

easily installed A complete and automatic package, the SCALEFREE 230 was installed by the maintenance crew at the plant in 16 manhours. Only inlet and outlet piping and simple electrical connections were required for the installation. The heater can be operated with any type of industrial gas – manufactured or natural.

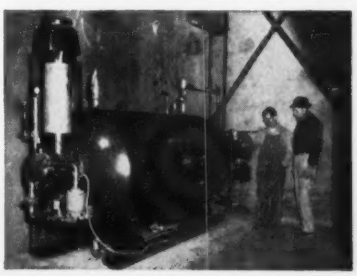
pre-krete®-lined General Refractories has assured itself of rust-free service water by specifying that the tank interior be lined with PRE-KRETE – a cement-base, plasticized material of high corrosion resistance. "It's just the thing for us," states the Plant Superintendent, "our water here in Carter County is full of minerals."

p-k scalefree 230 is available in plain steel or with linings of Pre-Krete or copper. Factory insulation optional. Storage capacities from 250 to 4,000 gallons; recovery sections from 390,000 to 2,215,000 BTU.

*Patent pending

Patterson Kelley

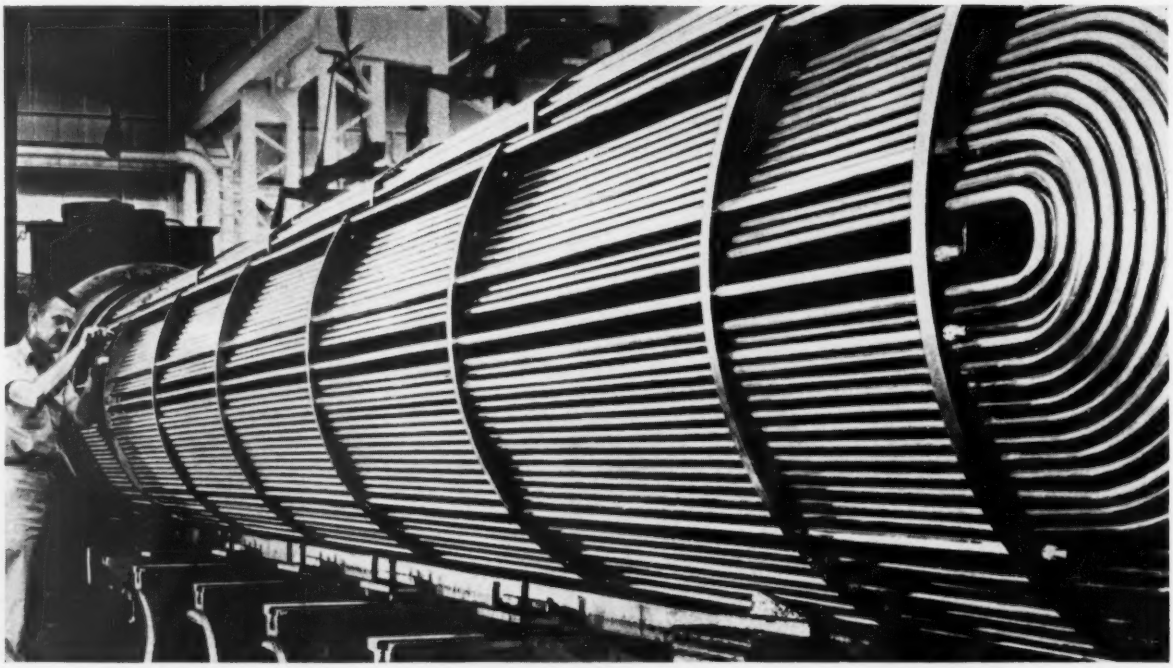
Water Heater Division, East Stroudsburg, Penna.



Installation of the SCALEFREE 230 took maintenance crew at General Refractories only 16 manhours.

For complete engineering and performance data SEND FOR P-K BULLETIN NO. 4

For more facts circle 232 on Reader Service card, p 103



What kind of tubing do modern feedwater heaters need?

Tubing for today's feedwater heaters must be strong to handle higher pressures and temperatures in modern steam plants. It must be made of a corrosion-resisting metal with good heat transfer properties. It must be workable and weldable to permit bending and attaching to tube sheets. In addition, it must insure long, trouble-free service.

There's one tubing material – Monel* nickel-copper alloy—that offers all these advantages:

- **Higher design stresses.** Without increasing tube wall thicknesses, stress relieved Monel tubing can be used for higher pressures. The latest revision to ASME Boiler Code, SB-163, allows an increase of approximately 5% in existing design stresses.
- **Better all-around corrosion resistance.** Monel resists corrosion by waters of all sorts.
- **High ductility.** Monel has good ductility for rolling and bending – permits unannealed tube ends. High ductility means tight rolled joints, and ease of forming hairpin bends.
- **Easy weldability.** Welding Monel alloy tubes to steel tube sheets is no problem. The alloy fuses well to form a strong, sound weld. Its coefficient of expansion is close to that of steel tube sheets.
- **Product quality.** Continual inspection and testing from refinery furnace to finished form result in the unvarying quality of Huntington Alloy Products tubing.
- **Long length tubing available.** The automatic cold draw bench at Huntington Alloy Products mill makes Monel tubes *as long as 85 feet!* This enables designers to take advantage of greater heating area in the tube bundles, and to effect economies by specifying longer heaters of smaller diameters.
- **Prompt deliveries.** With new facilities in full operation, prompt deliveries of your Monel tubing requirements can be assured. Special attention will be given to retubing jobs, where prompt delivery is important. Orders are accepted on a basis of 8 week delivery.

Keep Monel alloy in mind when you design or retube a high pressure heat exchanger. For more information on Monel alloy, write for bulletin T-5, "Engineering Properties of Monel and 'R' Monel Alloys." *Inco trademark

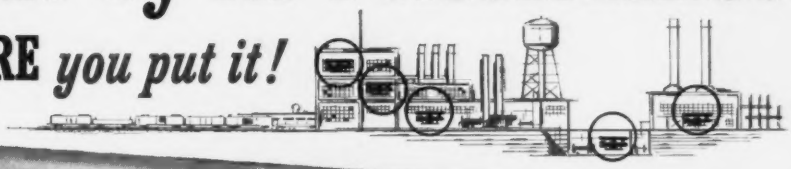
HUNTINGTON ALLOY PRODUCTS DIVISION
The International Nickel Company, Inc.
Huntington 17, West Virginia

MONEL.®

For more facts circle 233 on Reader Service card, p 103

Conspicuous by its Performance

...no matter WHERE you put it!



Clark Model CMB-2 Balanced/Opposed Air Compressor rated at 400 bhp. Models available from 75 to 8000 bhp.

CLARK
Balanced/Opposed
AIR COMPRESSOR

Air Power—100 lb. Variety—The kind that is economical, dependable . . . That's what you get with a compact Clark Balanced/Opposed Air compressor. You may hide it in the basement or the boiler room, but this smooth running veteran will always be conspicuous by its performance.

Efficiency at All Key Points—Compressor cylinders utilize large, streamlined air passages and optimum number of valves to minimize pressure drop, turbulence and valve losses. The heavy duty *Simplaire* valve has only one moving part on the low pressure suction side. Its webbed disc valve ring is opposed by minimum spring force, operates with less total differential pressure than any other compressor valve design. The Clark intercooler is carefully engineered for highest possible heat transfer rates. Double wall construction provides a large surge chamber to minimize pressure drop and assure maximum delivery of air.

A Real Space Saver—Squeeze it into "impossible" places . . . install large amounts of horsepower in limited areas. Compact Clark design with overhung integrally supported rotor makes the most of available space, eliminates bulky extension shafts with outboard bearings and flywheel.

Perfect Running Balance—Clark Balanced/Opposed design cancels out primary and secondary unbalanced forces. Units run smooth and quiet, thereby easing wear on moving parts. Foundations need only be large enough to support the physical weight of the compressor. You can locate a Clark machine anywhere . . . with confidence.

Low, Low Maintenance—Internal components are easy to get at, easy to service. Clark *Simplaire* valves are ultra simple in design, can be readily installed, or disassembled and cleaned. Valve bodies and housings of like size are completely interchangeable for suction or discharge, offer no alignment problems.

Put Greater Efficiency into every compressor dollar you spend. Contact your nearest Clark representative for full details, or write for Bulletin 185.

CLARK GAS TURBINES

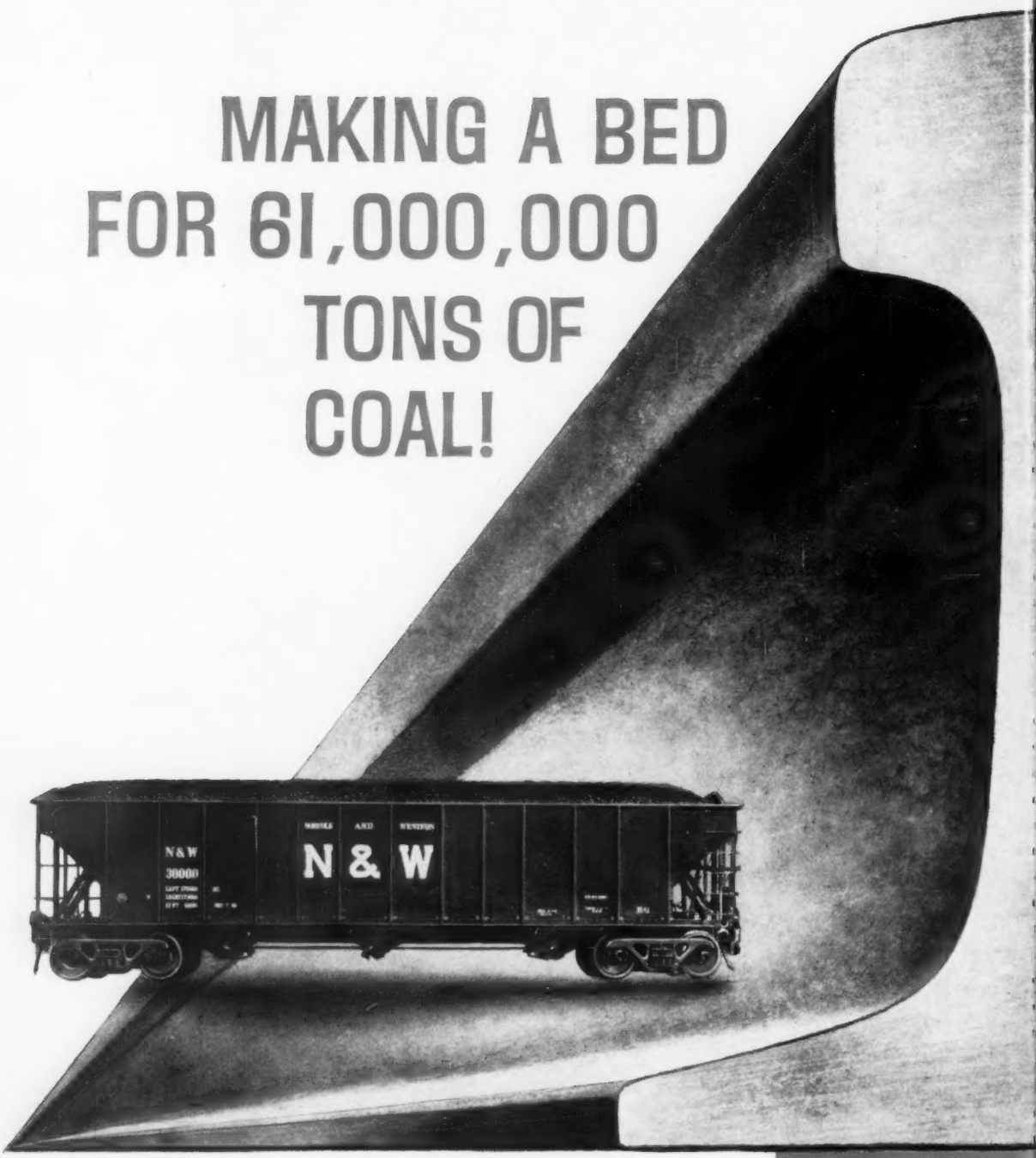
DRESSER INDUSTRIES INC.

OIL • GAS • CHEMICAL
ELECTRONIC • INDUSTRIAL

CLARK BROS. CO., OLEAN, N.Y.

For more facts circle 234 on Reader Service card, p 103

MAKING A BED FOR 61,000,000 TONS OF COAL!



A solid, expertly maintained roadbed means smoother, faster transportation of coal . . . increased safety and delivery of shipments in A-1 condition.

N&W's rugged roadbed is only part of the story. Fleets of expertly maintained cars, like our brand new 85-ton roller bearing hoppers . . . pushbutton classification yards . . . the nation's newest fleet of locomotives . . . finest weighing equipment . . . are some of the other reasons that help assure prompt, dependable delivery of coal. More than ever, you're on the right track when you buy the superior, all-purpose coals from mines along the service-minded N&W!

NORFOLK AND WESTERN RAILWAY

GENERAL OFFICES ROANOKE, VIRGINIA

Welded rail is being used increasingly on the N&W to provide a stronger, smoother track which means more efficient transportation of your coal.

Most N&W rail is heavy — 130 lb. or better — to give safer, better service under the pounding of fast-moving, 200-car N&W coal trains.

Mechanized maintenance of track and roadbed is fast and thorough. Special detector cars and ultrasonic equipment test rails regularly.

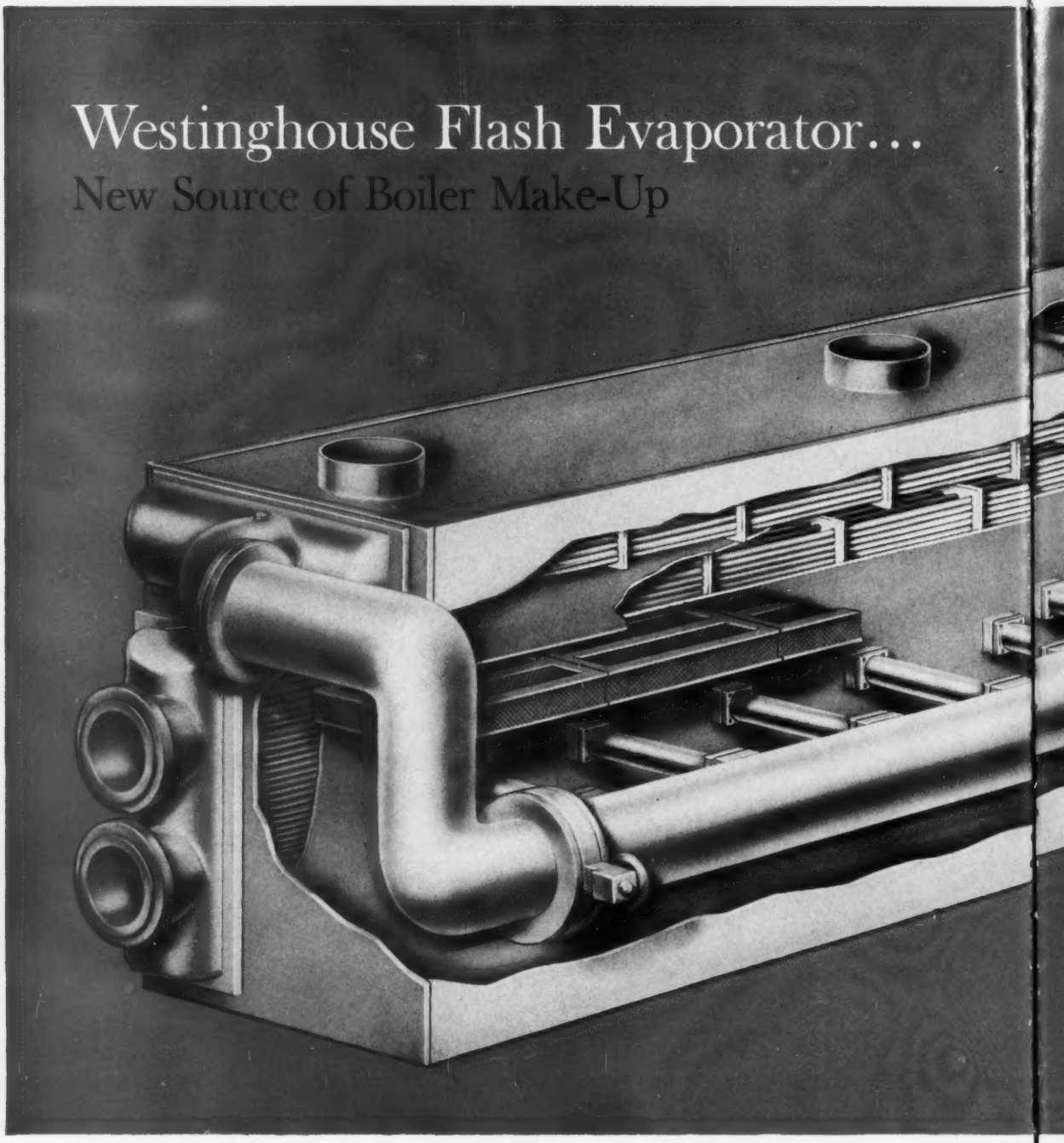
N&W

America's largest originating coal railroad.

For more facts circle 235 on Reader Service card, p 103

Westinghouse Flash Evaporator...

New Source of Boiler Make-Up

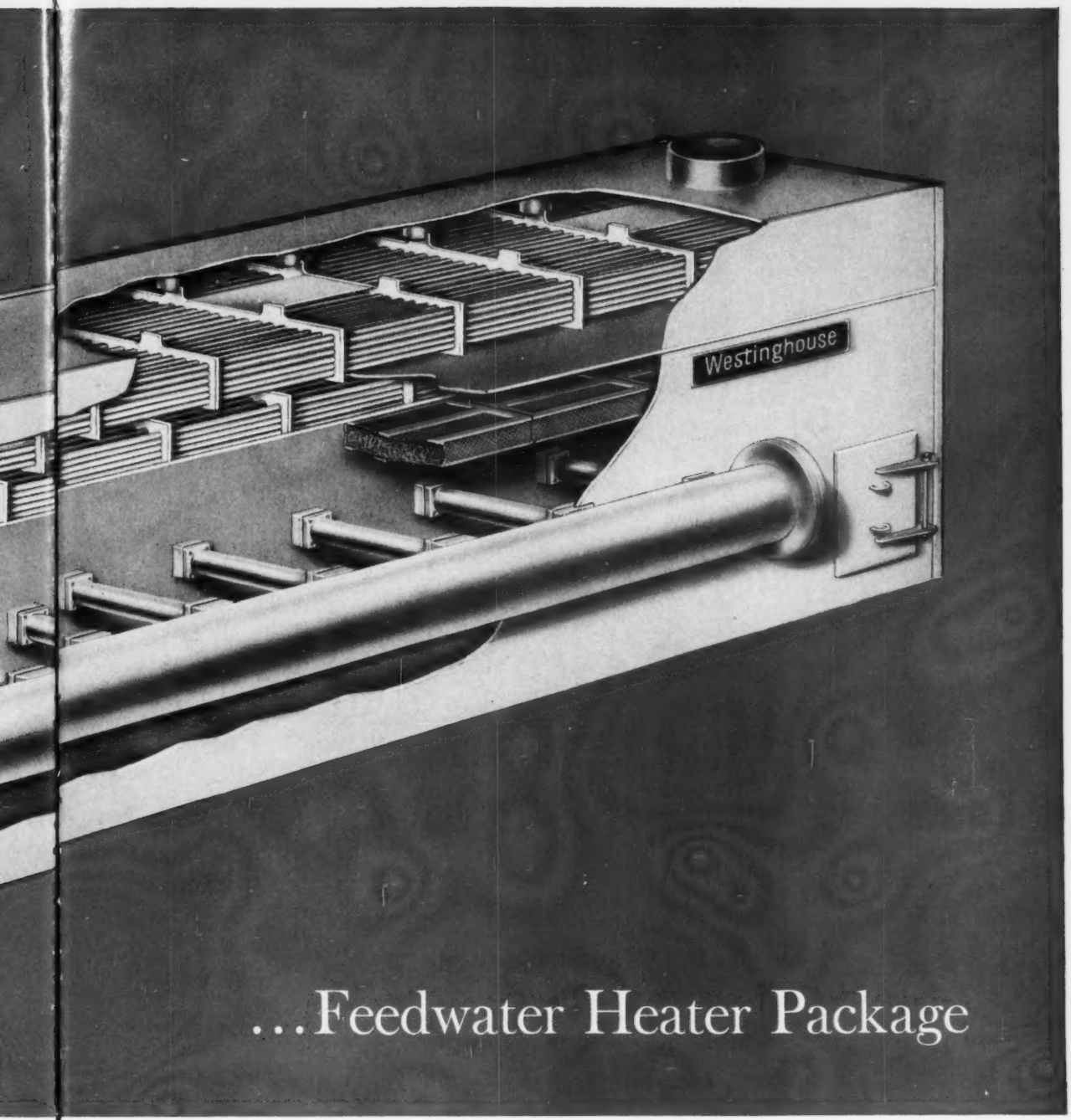


economy

No impairment to cycle efficiency/Integral piping reduces plant cost

purity

0.05 ppm from fresh water guaranteed/0.25 ppm from salt water guaranteed



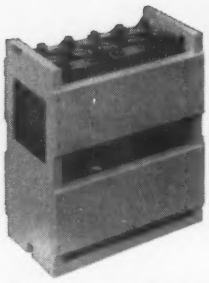
...Feedwater Heater Package

adaptability

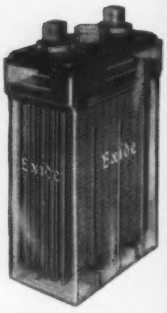
High overload capacity/Feedwater heaters integral with evaporator

You can be sure . . . if it's Westinghouse J-50619

Westinghouse

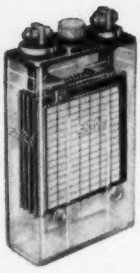


Low-maintenance pocket positive nickel-cadmium

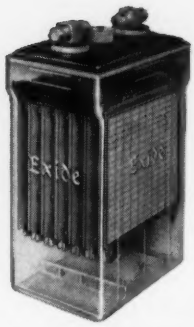


New 20-year Exide-Ironclad tubular with Silvium*

MATCH BATTERY POWER TO YOUR NEEDS AND SAVE MONEY



Flat plate Tytex with Silvium or calcium



Long life Exide-Manchex, Planté type, with Silvium

Trickle or Hi-Lo charger

Constant voltage charger

This is what you get in the Exide Power Package. For your particular application, you need a particular type and size battery for maximum economy. Then you need a particular charger. And you need a certain amount of regular service.

Exide is in the unique position to provide the exact battery, charger and service that your particular application requirements call for. Only Exide offers so broad a line of batteries and chargers. And only Exide has such a well-trained field force of factory supervised service specialists.

An Exide Power Package not only insures you of getting the power you need, but it protects you from overspending on capacity you don't need. And you get everything from one dependable source. It's your easiest, surest way of getting maximum battery power economy. Write for complete information. Exide Industrial Marketing Division, The Electric Storage Battery Company, Philadelphia 20, Pa.

*Silvium is Exide's patented corrosion-resistant grid alloy

Exide®

INDUSTRIAL MARKETING DIVISION
The Electric Storage Battery Company

ESB

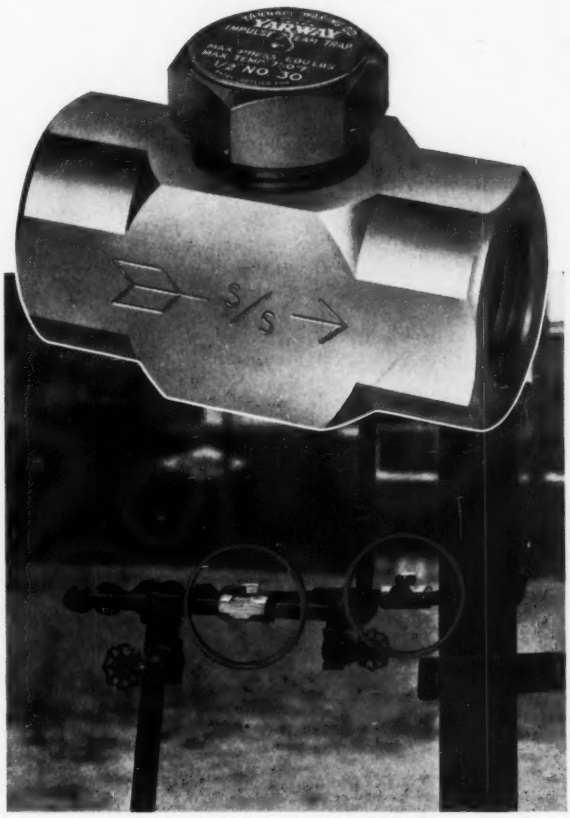
For more facts circle 237 on Reader Service card, p 103

YARWAY news briefs

from **Yarnall-Waring Company,** *Philadelphia 18, Pa.*

BRANCH OFFICES IN 19 UNITED STATES CITIES • SALES REPRESENTATIVES THROUGHOUT THE WORLD
STEAM TRAPS STOCKED AND SOLD BY 270 LOCAL INDUSTRIAL DISTRIBUTORS

YARWAY SERIES 30 IS THE STEAM TRAP FOR PEAK EFFICIENCY



Two Yarway Series 30 traps on tracer lines from a loading station to polystyrene storage tank at the Midland Division of The Dow Chemical Co., Midland, Mich. Steam pressure is 150 pounds.

on tracer lines, main drips, meter boxes and other steam equipment

Yarway Series 30 Impulse Steam Trap has won enthusiastic acceptance and scored outstanding success on those hundreds of applications where condensate is handled in moderate amounts. Here's why:

- Economy of operation, with closer condensate control
- Longer service life, with lever action reducing impact on valve seat
- Lower maintenance, with easily and quickly replaceable seat and disc
- High quality, all stainless steel—combined with a new low cost

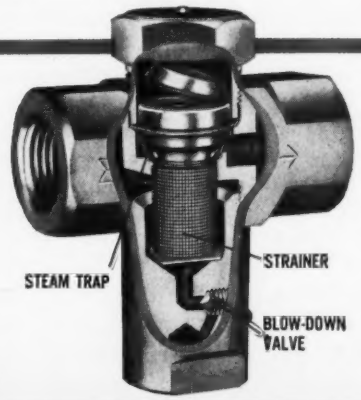
Here are a few typical user experiences:

TEXAS REFINERY—*Been using ½" No. 30's on drip legs to steam lines for 6 months. "No troubles whatsoever."*

PENNSYLVANIA TIRE MFR.—*Gradually replacing all traps on tire molds with Yarway No. 30's. "Amazed at their performance."*

MISSOURI STEEL PLANT—*Tested Yarway No. 30's against competitive traps, with result "Yarway No. 30 now standard on all main steam header drips."*

So it goes in plant after plant. Why don't *you* try Yarway Series 30 Traps? Available in ⅜" or ½" size; pressures 8 to 600 psi. Your nearby Industrial Distributor carries them. Write for his name.



NEW! COMPACT COMBINATION

NEW SERIES 130 steam trap combines a Series 30 trap, a strainer, and blow-down valve *all in one compact unit*—with these advantages:

- Saves space
- Saves installation costs
- Saves weight
- Saves on maintenance

Stainless steel construction, good for all pressures 8 to 600 psi.

Your Yarway distributor has SERIES 130 traps. Try one today—or write for new Bulletin T-1743-B.

For more facts circle 238 on Reader Service card, p 103

B&W's
NEW FITTINGS
PLANT IS IN
FULL OPERATION

NOW YOU CAN REALLY

SIMPLIFY YOUR PIPING PURCHASES

The complete integration of B&W facilities . . . their steel mill and their tube mills with the new Welding Fittings plant can play an important part in reducing your piping purchase problems. Now you can get a complete process piping package . . . welding fittings, flange *and* tubular products from one dependable source. Now you can get a complete process piping package that is quality-controlled . . . matched to end-use service. And you can get on-time deliveries of fittings, flanges and pipe made from the specialized steels because B&W can control scheduling from steel melt to shipment of the finished product. The Babcock & Wilcox Company, Tubular Products Division, Fittings Plant, P. O. Box 230, Beaver Falls, Pennsylvania.

B&W

THE BABCOCK & WILCOX COMPANY

TUBULAR PRODUCTS DIVISION

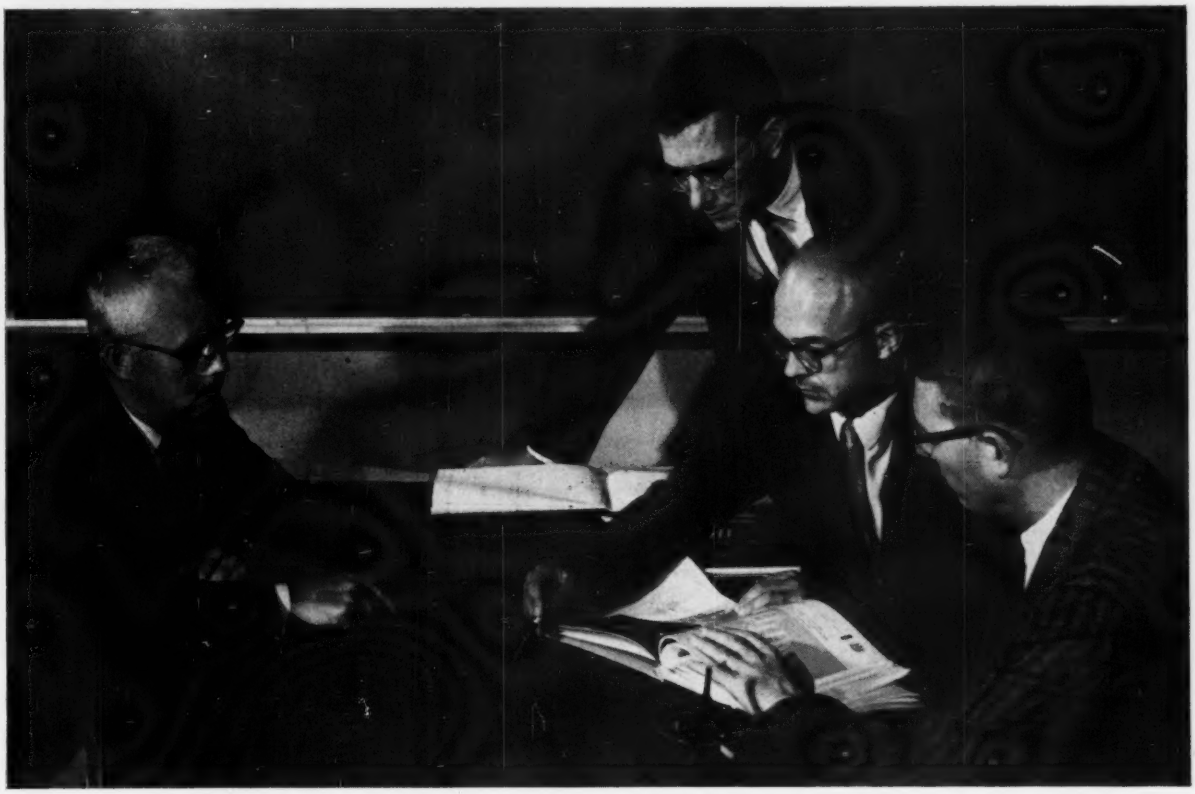
TA 1019 F

Seamless and welded tubular products, solid extrusions, seamless welding fittings and forged steel flanges—in carbon, alloy and stainless steels and special metals

For more facts circle 239 on Reader Service card, p 103

SILICONE NEWS from Dow Corning

Blueprint for Reliability



For Performance Plus...Specify Silicone Insulated Transformers

Here's Why—(1) *Low cost installation* . . . transformers using silicone insulation systems are up to 50% lighter, 50% smaller and require no costly vaults or barriers. (2) *Lower operating costs* . . . silicone insulated transformers are virtually maintenance-free — have no liquids to filter or change — need no space heaters to keep de-energized windings dry. (3) *Maximum safety* . . . silicone insulated transformers are completely dry. There's no danger of toxic fumes, or fire. (4) *Maximum reliability* . . . silicone insulated transformers operating at 200 C have a longer life expectancy than Class A transformers operating at 100 C. Depending on design, silicone insulated transformers withstand overloads of 25 to 50% above rated capacity. Units have been flooded without damage to windings.

Here's How — Dow Corning silicone insulation has excellent electric strength and is unaffected by thermal cycling and high temperature . . . enables transformer manufacturers to (1) produce lighter, more compact units — units that double capacity without increasing space or weight requirements; or (2) build units that withstand substantial overloads.

Here's What — Silicone insulated dry-type transformers in three enclosures: (1) open, (2) enclosed and (3) gas-filled sealed.

Here's Where — For power station auxiliaries, a choice of enclosed, open or sealed gas-filled dry-type transformers — and, for underground distribution systems, sealed gas-filled dry-type transformers.

Here's When — Right now! Whether you are planning for future growth, expanding present facilities or replacing old equipment, consider the possibility of using silicone insulated transformers. Initial price is competitive, and, when you consider their lasting values, silicone insulated transformers give you more for your money . . . a whole lot more!

Write today for 8 page brochure entitled "Specify Silicone Insulated Motors and Transformers and Save!"

You Save by Specifying Silicone Insulated Transformers. Write Dept. 7016.

first in silicones

Dow Corning CORPORATION
MIDLAND, MICHIGAN

ATLANTA BOSTON CHICAGO CLEVELAND DALLAS LOS ANGELES NEW YORK WASHINGTON, D. C.

For more facts circle 240 on Reader Service card, p 103

nstalling a Cooper-Bessemer DMR-3 Air Compressor for foundry service.

George Edick, *Domestic Sales Manager, The Cooper-Bessemer Corporation, and* Floyd Paschke, *Sales Manager, The Rotor Tool Company, explain . . .*

How to boost your productivity with compressed air

The thing that counts in getting top output with air tools is *air pressure at the tool, under load.* Is this productivity what it should be in *your* plant? Here is a service that helps you find out *for sure . . .*

The teaming up of application service engineering of Cooper-Bessemer and its new subsidiary, Rotor Tool, provides full-scope experience to help you analyze your compressed air needs and plan your facilities for optimum production efficency. This experience encompasses the study of compressor capacity requirements, number of compressors and their location for greatest economy, regulation of the plant, the distribution system and portable air tools. This service is yours without obligation.

It will pay you to call in the nearby application engineer of Cooper-Bessemer or Rotor Tool to help you make sure that you are getting maximum productivity with compressed air.

BRANCH OFFICES: Grove City • New York • Washington Gloucester • Pittsburgh • Chicago • Minneapolis • St. Louis • Kansas City • Tulsa • New Orleans • Shreveport • Houston • Greggton • Dallas Odessa • Pampa • Casper • Seattle • San Francisco • Los Angeles

SUBSIDIARIES: Cooper-Bessemer of Canada, Ltd. . . . Edmonton Calgary • Toronto • Halifax • Stratford

C-B Southern, Inc. . . . Houston

Cooper-Bessemer International Corp. . . . New York • Caracas • Anaco

Cooper-Bessemer, S.A. . . . Chur, Switzerland • The Hague, Netherlands Mexico City

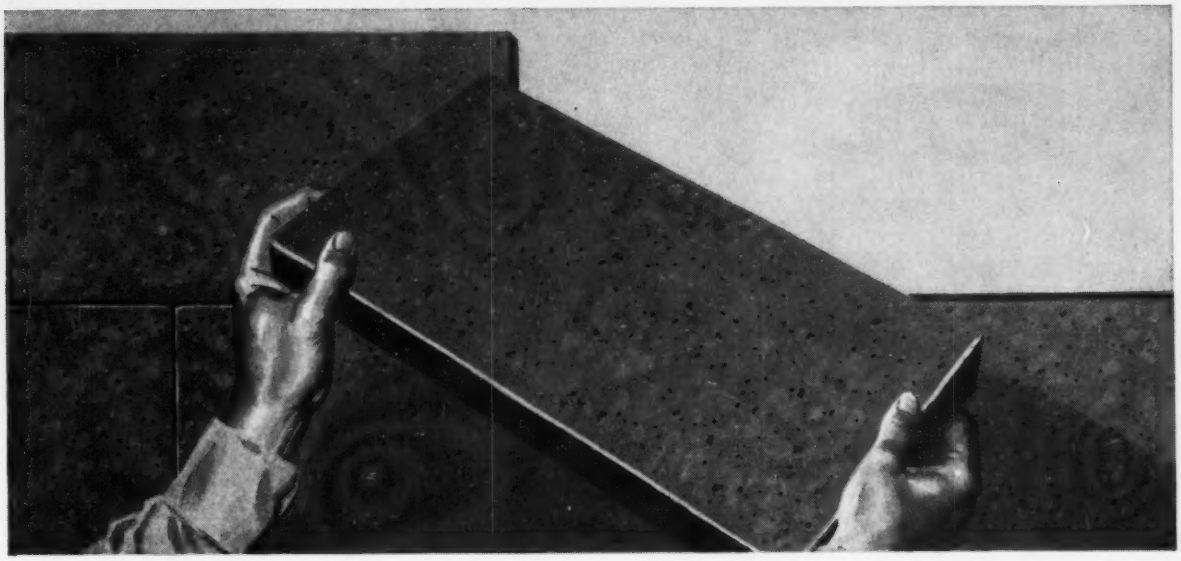
The Rotor Tool Company . . . Cleveland

Cooper Bessemer

GENERAL OFFICES: MOUNT VERNON, OHIO

ENGINES: GAS - DIESEL - GAS-DIESEL
COMPRESSORS: RECIPROCATING AND CENTRIFUGAL
ENGINE, TURBINE OR MOTOR DRIVEN

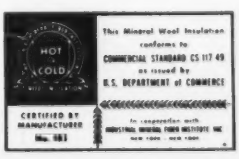
A TRUE-CUT BLOCK WITH PRECISION-FINISH!



- Eagle-Picher's "precision-finish" is one of the most important insulation developments in years.
- Highly efficient, all-purpose block that is practically dustless.
- Great structural strength! Meets rigid demands for long-lasting block able to withstand wide temperature range up to 1900 F.
- Lightweight, easily installed! Easily cut to fit irregular areas—no special tools needed. Requires only minimum reinforcing.
- Effectively resists steam and other moisture! Does not disintegrate or lose thermal efficiency under heavy duty service.

EAGLE-PICHER
PV SUPERTEMP
BLOCK INSULATION

Eagle-Picher produces a complete line of industrial insulations for all temperatures from below Zero to over 2000 F.



Since 1843
The EAGLE-PICHER Company
Dept. P-461
Cincinnati 1, Ohio

EAGLE EP PICHER

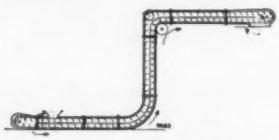
STEPHENS-ADAMSON

moves bulk material en masse vertically — horizontally — on inclines or around bends with REDLER® CONVEYOR-ELEVATOR SYSTEMS

S-A REDLER Conveyor-Elevators have a coveted 25 year reputation of successful operation. Well over 20,000 units handle a wide range of pulverized, granular, small lump and flaked materials in plants throughout the world. The REDLER Conveyor-Elevator moves material by EN MASSE action horizontally, vertically, on inclines or around bend corners. Material movement is continuous within totally enclosed, dust-tight compact casings, permitting large tonnage handling in small space. REDLER Conveyor-Elevators can be adapted to removing solids from a liquid bath in solvent extraction plants. The conveying elements, a series of U-type skeleton flights shown above in cut-away, move readily around sprockets and bend corners with relatively low power required at the drive. Skeleton flights may be easily unhooked and replaced without tools. S-A REDLER Conveyor-Elevator Systems speed efficiency reducing bulk materials handling to lowest cost per ton.

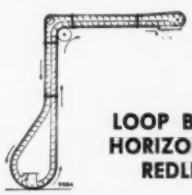
L-TYPE REDLER

Lower run can be horizontal or inclined. Elevating run can be operated at any required inclination. Special discharge openings can be spaced anywhere. Discharge to any one of three sides. Many variations of standard L-Type system available.



Z-TYPE REDLER

Combines two horizontal conveyors and one vertical elevator into one compact unit. One feedpoint, one discharge and one drive. Feed from choked feedpoints on horizontal run.



LOOP BOOT HORIZONTAL REDLER

Simplest form for elevating material up steep inclines. Column of material is supported on all four sides at inclines above the angle of slide for materials handled. Low headroom for feedpoints. Discharge gates placed wherever needed.

HORIZONTAL CLOSED CIRCUIT REDLER

"Run-around" type system employs side-pull conveying element. Permits conveying in several directions on horizontal plane. Available in two-way version featuring 180° bends and four-way version featuring 90° bends.

WRITE FOR BULLETIN 358

S-A
ENGINEERED BULK HANDLING SYSTEMS
MATERIALS HANDLING PRODUCTS
SPEEDWALK® PASSENGER CONVEYORS
ROLLMASTER® ROLL BEARING UNITS
SPHERICO® BEARINGS & ROD ENDS

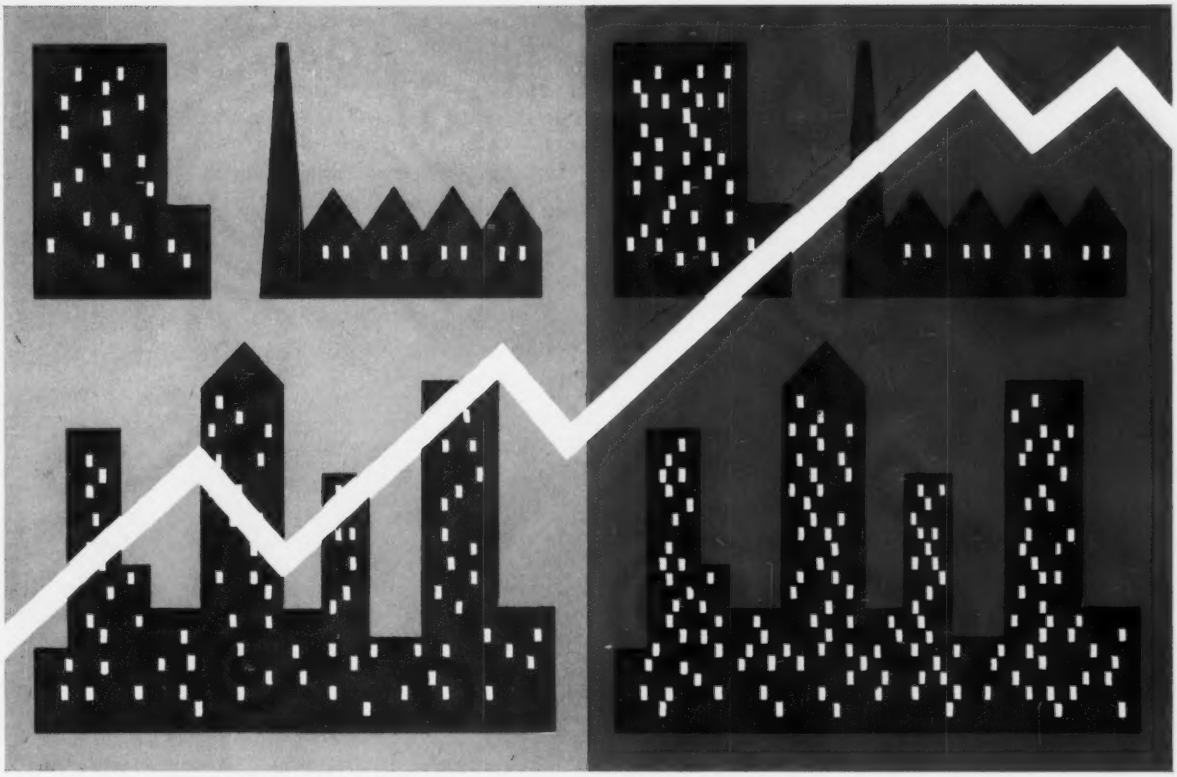
ENGINEERING DIVISION

STEPHENS-ADAMSON MFG. CO.

GENERAL OFFICE & MAIN PLANT, 5 RIDGEWAY AVE., AURORA, ILL.

PLANTS LOCATED IN: LOS ANGELES, CALIF. • CLARKSDALE, MISS.
BELLEVILLE, ONT. • MEXICO CITY, D. F.

For more facts circle 243 on Reader Service card, p 103



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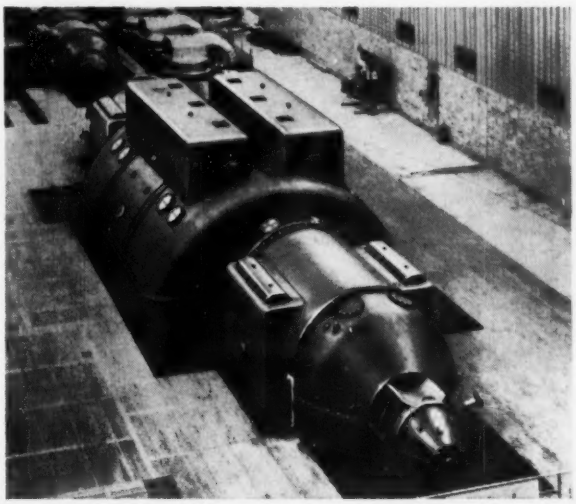

Two 160 MW machines installed in an underground power station at Stenungsund, Sweden, have achieved an overall efficiency including boilers and auxiliaries of 39%. This station, operated by the Swedish State Power Board, is the world's largest, newest underground steam power plant; a certified turbine heat rate of 7,785 btu/kwhr. has been achieved by these STAL machines.

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LOUIS N ROWLEY, EDITOR • APRIL 1961 • ESTABLISHED 1882 **Power**

Do you "sweat the small ones?"

When I get after my youngest son for some minor oversight, his reply is apt to be: "Aw, Pop, don't sweat the small ones!" In everyday human affairs that may often be good advice, and we may fret ourselves unduly over small matters. But in the energy-systems field, small matters often loom large when viewed in true perspective.

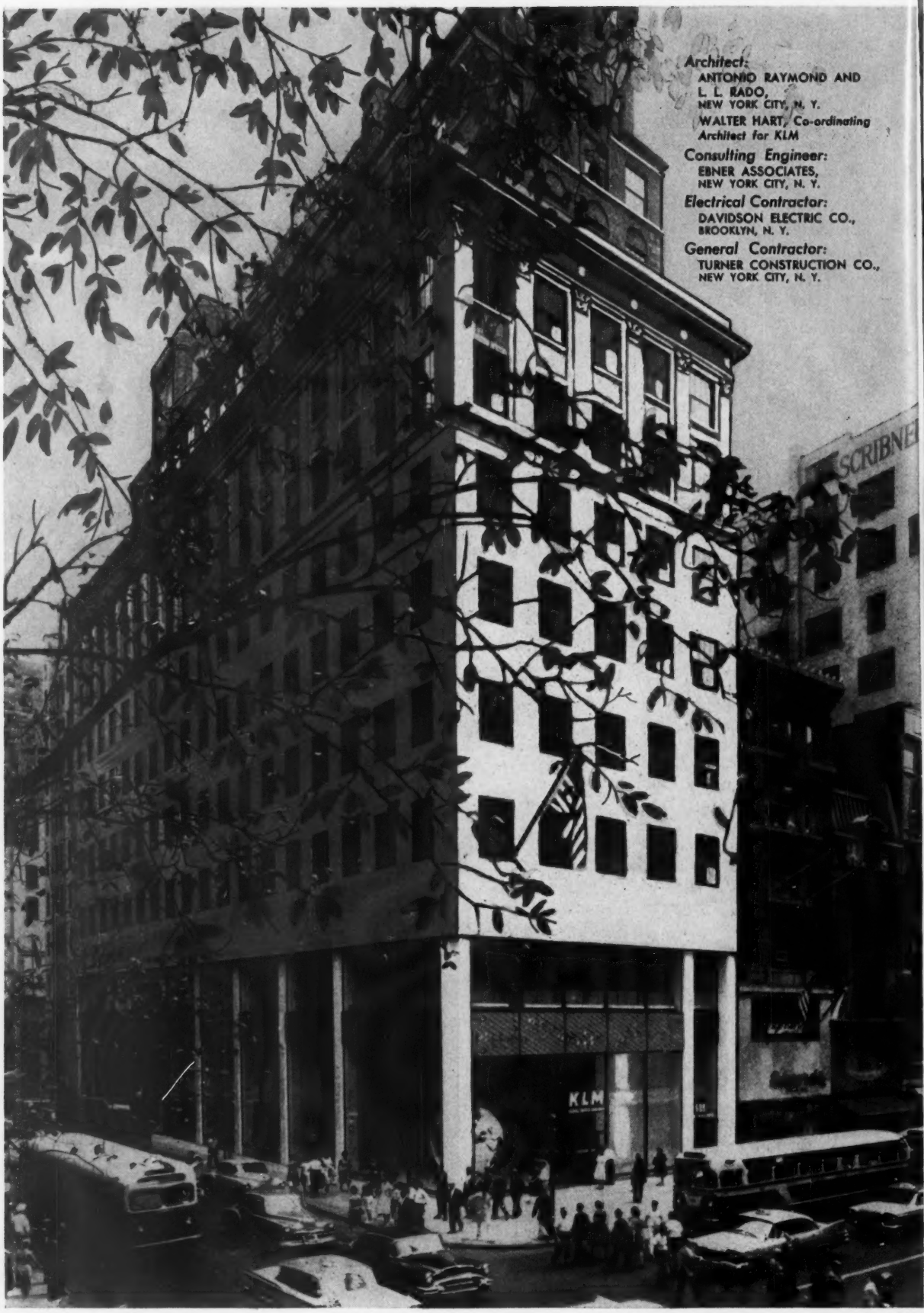
I'm reminded of this by a letter from long-time POWER subscriber C R Welch, who mentions a 30-year-old plant in South America that had always operated with steam on all nozzles of the air ejectors. Investigation revealed that shutting off one nozzle of each set not only reduced steam consumption but improved condenser performance. Had this kind of experimenting been done when the plant was new, approximately one-quarter of a million dollars would have been saved! Here is a small facet of plant operation, one that seems insignificant at first blush. But look what it mounts up to when the effects are carefully calculated and applied over the plant's lifetime.

Reader Welch mentions another old plant in which extraction heaters had never been cleaned. There didn't seem to be any reason why they should be cleaned, according to the operators, who said, in effect, "they're still working, aren't they?" And they *were* working, but a chemical-cleaning job made them work a great deal better, boosted overall efficiency by 3%.

That 3%, over the years, could pile up to a substantial figure, even in a small plant. In a large central station, one percentage point in thermal efficiency can represent tens of thousands of tons of coal, hundreds of thousands of dollars, each year.

These are examples of small details that gain importance when they are acted on by powerful multipliers such as long periods of time or extremely large outputs. And, as every energy-systems engineer knows, there are some details that cannot be ignored because of their key importance in safe operation—protective relays, for example.

So, my son to the contrary, there *are* times when it pays to "sweat the small ones." As plant designers and managers we need to learn the trick of steering the right course between two extremes: the excessive concern with trifling detail that leaves no time or energy for the overall situation, and the preoccupation with the "big picture" that scorns any attention to "mere details." Perhaps most important of all, we need to keep our operating staffs from sliding into the easy habit of taking things as they are, without regular hard looks to see what could be done better and cheaper.



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NEW YORK CITY, N. Y.
WALTER HART, *Co-ordinating Architect for KLM*

Consulting Engineer:
EBNER ASSOCIATES,
NEW YORK CITY, N. Y.

Electrical Contractor:
DAVIDSON ELECTRIC CO.,
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General Contractor:
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Electrical Protection *is MODERNIZED* with BUSS fuses in the KLM Royal Dutch Airlines Building, New York City

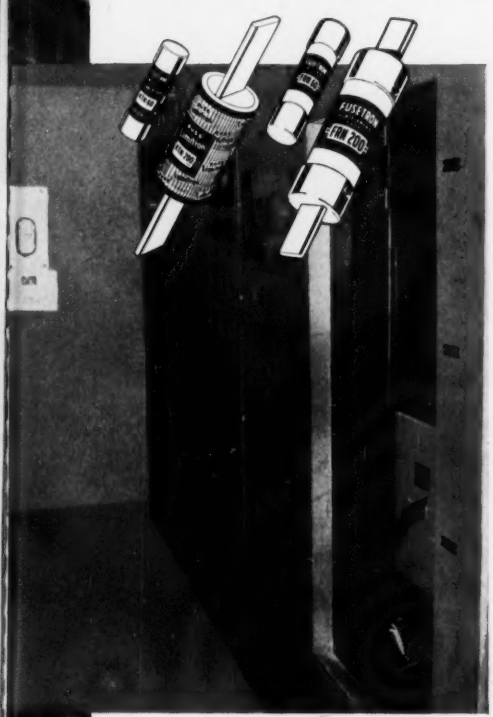
KLM INSTALLATION POINTS OUT THE NEED FOR SAFE INTERRUPTION OF HIGH FAULT CURRENTS

A 3 million dollar modernization program was recently completed on this 13 story office building at 609 Fifth Ave., which houses the American Executive and first floor ticket offices of KLM Royal Dutch Airlines.

To meet power requirements, the capacity of the electrical system was greatly increased, resulting in an estimated available fault current level approaching 100,000 amperes.

In the main switchboard, Buss LIMITRON fuses are installed to provide the high interrupting capacity necessitated by the available fault current and to give great current limitation needed to protect circuits and equipment.

To further assure safe protection and to safeguard against needless outages, distribution and feeder circuits are equipped with FUSETRON dual-element fuses.



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As electrical network capacities increase, available fault currents of 75,000 to 100,000 amps and up are no longer uncommon.

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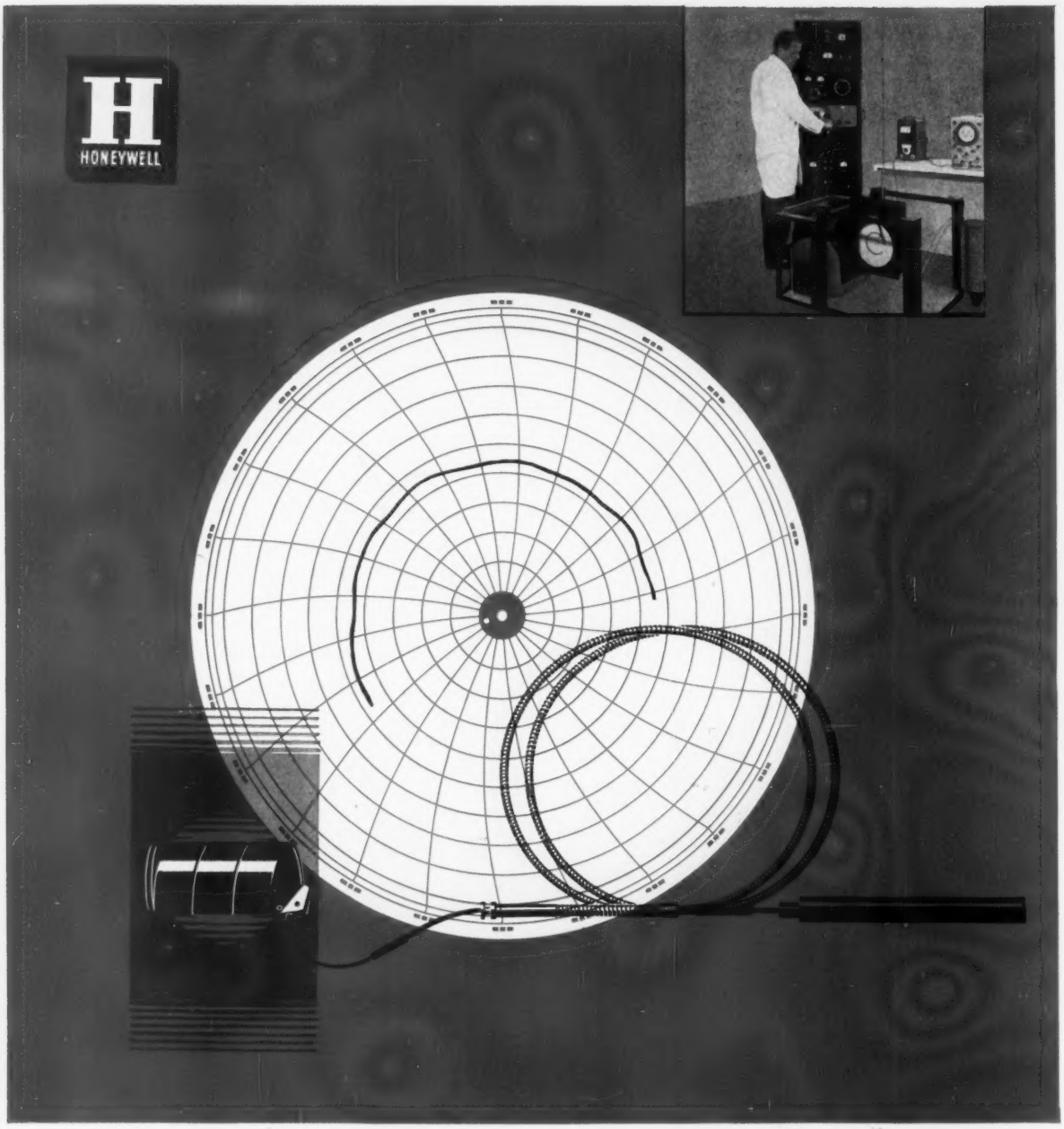

The New Honeywell Thermal System withstands extreme vibration and corrosion conditions

Here's a new gas-actuated thermal system that takes the zig-and-zag out of temperature recording under severe vibration conditions.

A complete series of vibration tests has proved the vibration resistance of the new Class III thermal system. In these tests (shown above), the Class III system was installed in a standard Honeywell rectangular case recorder, and subjected to forced vibrations in three mutually perpendicular planes. With accelerations up to 0.2G from 0 to 200 cps, maximum pen oscillation was limited to 1.5%. For more than 75% of the range, pen oscillation was less than 0.5%, with no resonant effects at 60 cycles.

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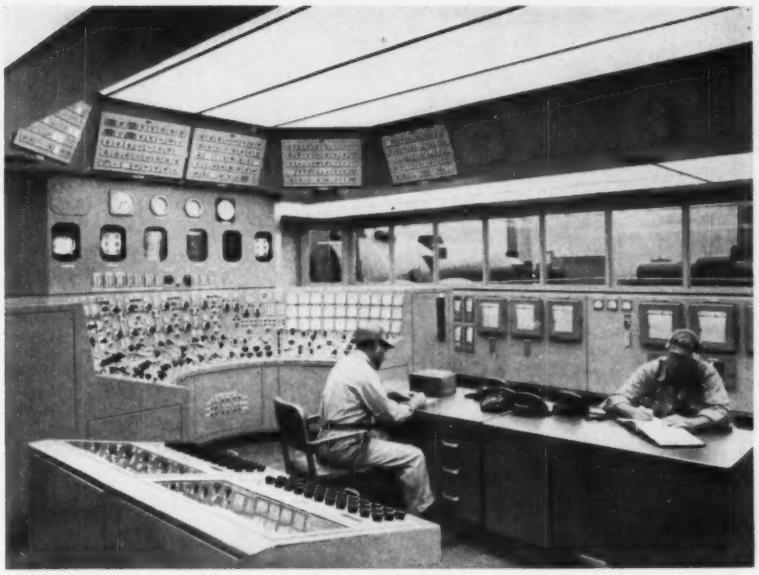
Design and equipment application section

B G A SKROTZKI
Associate Editor in Charge



CONTROL ROOM WITH SEMICIRCULAR CONSOLE for one unit has automatic data logger, left foreground, and computer opposite, not shown, other unit board at opposite end

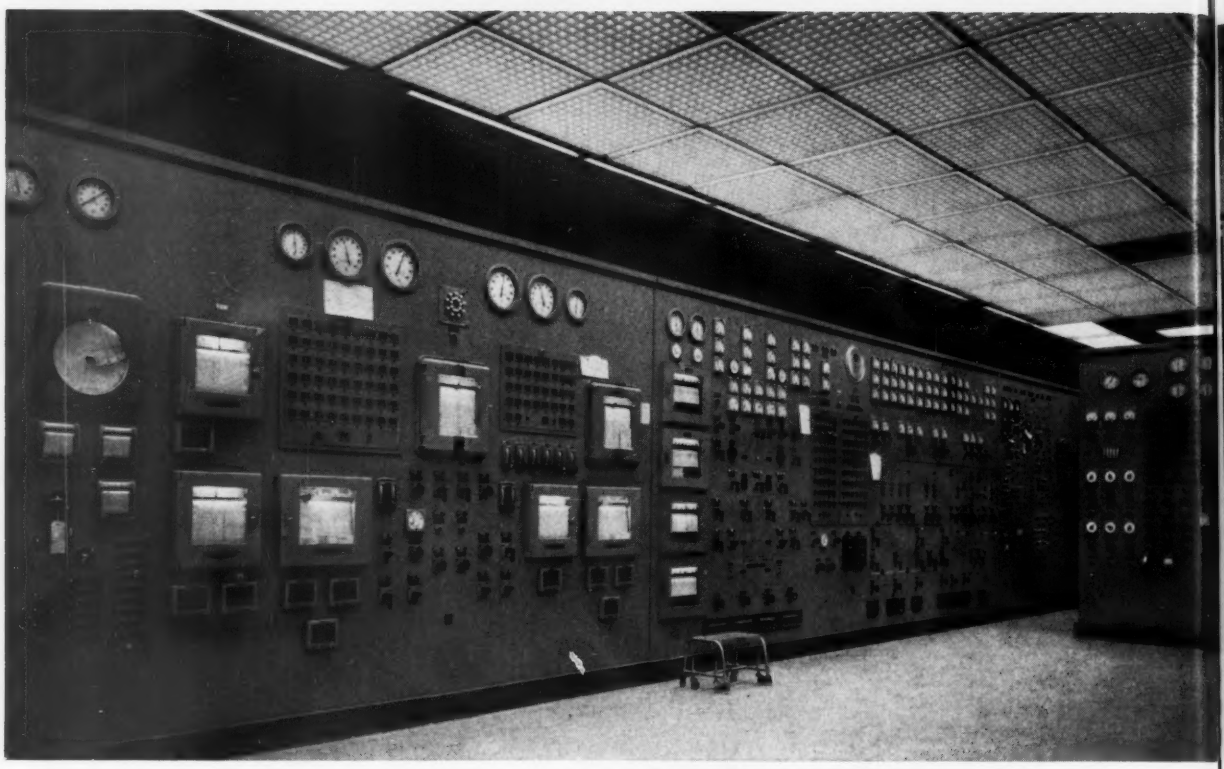
CENTRAL CONTROL ROOMS: ideas differ

With about a score of years of control-room design and use behind us there's still little agreement on what is the 'best' layout. Plant emergency experience has tempered ideas of some designers and operators while others push preliminary steps toward complete automation

By B G A SKROTZKI
Associate Editor

- Control rooms may be placed anywhere in plant
- Fire and smoke protection vary over wide range
- Capacity per control room affects system reliability
- Operators usually influence design of boards
- Combined electric-mechanical rooms most favored
- Miniature vs large instruments seems to be a draw
- Costs limit acceptance of automatic data loggers
- Modern plants cannot run with their control rooms out of commission

turn page ——►



Vertical board holds full-scale instruments and controls

This control room with 115 ft of vertical boards holds all equipment for coal handling, boiler, turbine, transmission switchyard and a substation 90 miles away. It also has an analog computer for heat rate

Sending some 900 items of data into a modern central-station control room poses the problem of effective use by the operators. The importance of this to plant safety seems to warrant psychological study, but little if any professional help has been used by control-room designers.

Human engineering has been of the practical cut-and-try variety. Designers decide on the board layout they want, from 3-ft panels to mammoth 115-ft vertical boards, often starting by building table-top models. The next step projects this to a full-scale mockup with photographs of instruments, controls and annunciators pasted in position. Plant operators are asked to criticize the mockups for arrangement, reach and convenience.

With operators satisfied, designers concentrate on internal arrangement of the boards to achieve installation economy, line and instrument accessibility, safety and ease of maintenance and calibration.

Control rooms warrant thorough study because trouble here may shut down the whole plant. Modern central stations cannot be run from the few local instrument and control boards at major components; these are only for startup and shutdown operation of equipment.

Operating-board layouts

The mimic-board layout for boiler and turbine instruments and controls seems to have run through its peak of acceptance. The mimic board has high value for initial operator training, but some former proponents now feel that the simpler modular-board arrangement eases layout and needs less movement on part of the operator. He quickly becomes familiar with relative location of controls and instruments on his board. Mimic buses, however, find much use on electrical control panels. Some operators prefer to have the board sections color-coded to help identify the area of the plant cycle—boiler, heaters, turbine, etc.—but this idea is not generally used.

Varied shapes of instrument faces and control handles for speedy identification find universal use. Controls are grouped on the board to make it easy for the operator to move through a "natural" sequence of steps during startups and shutdowns of plant components.

Type of board to use in a control room finds no unanimity of opinion. All agree on one point—the operator should stand in front of the board, not sit. The vertical board is the simplest type with all control handles, indicating and recording instruments mounted on the face. These boards are built as the outer side of a tunnel that can be entered at one end. This gives easy access to the back for maintenance, inspection and calibration.

Terminal and tube-coupling racks mount to the back of the board at right angles for a compact layout. This makes calibration connections easy. Some recording instruments may be mounted inside the tunnel when not

Benchboard with controls stands before vertical board

Control boards for boiler and turbine of one unit stand in control room with large glass windows. Electrical-control benchboard (with no vertical board) stands on opposite side of the control room

needed for continuing inspection by the unit operator.

Perhaps the most-used arrangement is the benchboard for controls and vital indicating instruments while a separate vertical board in back holds recorders, annunciators and secondary indicating instruments. Again the vertical boards are the tunnel type, but the benchboard interiors must be reached through openings in the control-room floor. This type of control room usually has a cable and terminal room underneath. The mechanics stand on a mezzanine grating below to work on the interior of the benchboards, controls and connections being overhead.

In a third type of arrangement a vertical board rises from the back edge of the benchboard as an integral unit. This brings instruments and annunciators closer to the operator for easier reading, demands less floor space in the control room making choice of location easier.

Miniature vs full scale

The compact board using miniature instruments and controls leads to a connection problem. These must be made in cramped quarters—but ingenious design of components overcomes this difficulty. Designers keep pushing manufacturers for improved miniature elements.

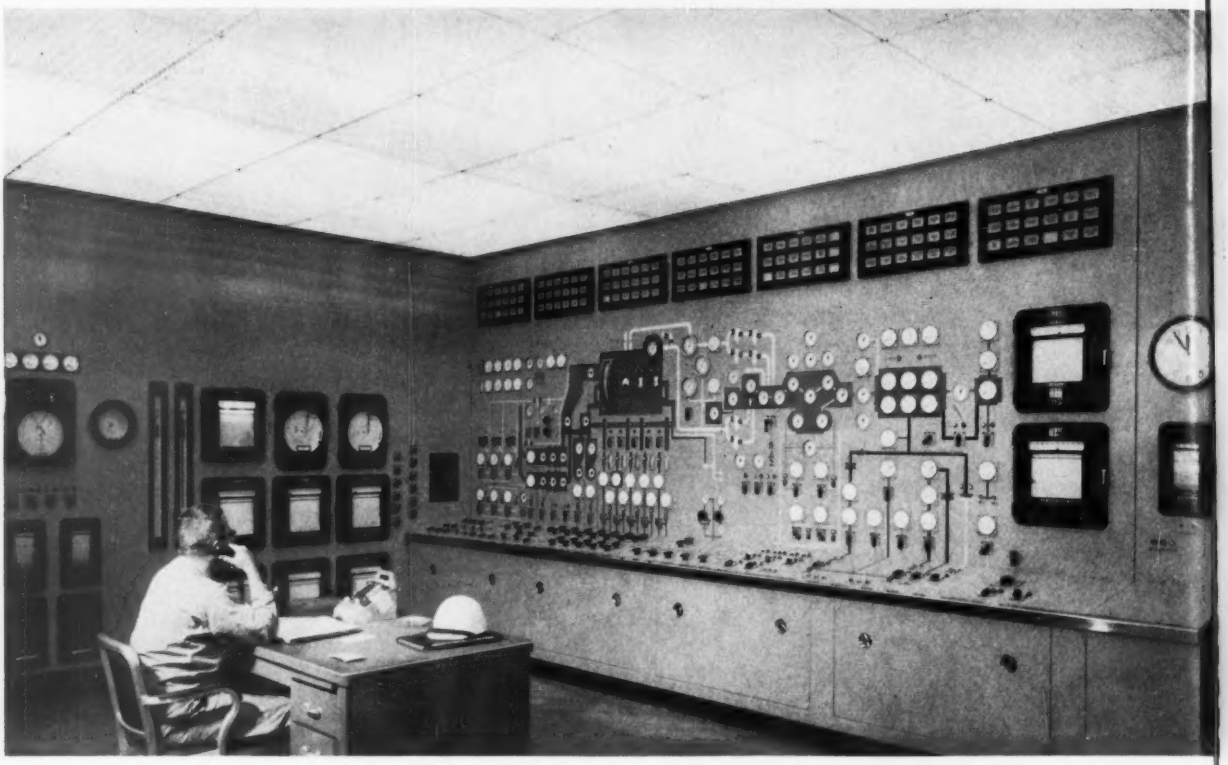
Some operators object to small instruments because of limited readability at a distance. They prefer to be able to read while seated at a desk several feet from the board. Other operators are willing to accept the miniature instrument if it has a long scale allowing a reasonable degree of precision reading when standing at the control board.

Proponents of the miniature board point out economy of eye and body movement by the operator during emergencies. The miniature board needs and can accommodate only one operator. This makes it impossible for two or more operators standing at a board to accidentally nullify each other's actions in emergencies and possibly shut down the plant when it's most needed.

The case for standard instruments and controls points out lower cost for equipment already available. Instrument maintenance appears easier with larger units. Actual size of a control room does not have any important bearing on the overall cost of the entire generating plant.

Control-room location

Where to put the control room? This seems to be decided by factors other than economy. The most popular criterion places the room at about the geometric center of the main equipment on the operating floor. This gives the roving operator the shortest distance to travel from his center of activities to any point in the plant—important during emergencies and convenient during normal startup and shutdown. Theoretically the central position also gives the shortest total runs for instrument and control lines. Besides lowering first cost this minimizes exposure of lines of potential danger of interruption. continued



Vertical board with attached benchboard needs less space

Mimic board using full-scale instruments can be read by operator sitting at desk. Board has instruments and controls for boiler, turbine and generator; most recorders mount on wall at left

When so located, most utilities prefer glass walls in the control room overlooking major equipment. This is a psychological factor rather than an operating one; of course equipment trouble usually shows itself through instruments in the control room, not at the equipment.

Control room for an underground hydro plant in Europe offers an interesting sidelight. Originally the room was to be underground, too. Windows would be installed—looking at illuminated painted landscapes. But finally the control room was placed above ground to avoid possible operator trouble from claustrophobia.

Some designers place the control room in any convenient space left in the plant after completing the design of main equipment. One plant has its control room in the stack base. Estimates show that the increase in connecting-line costs for any general placement within a plant versus a centered one is probably less than 10%.

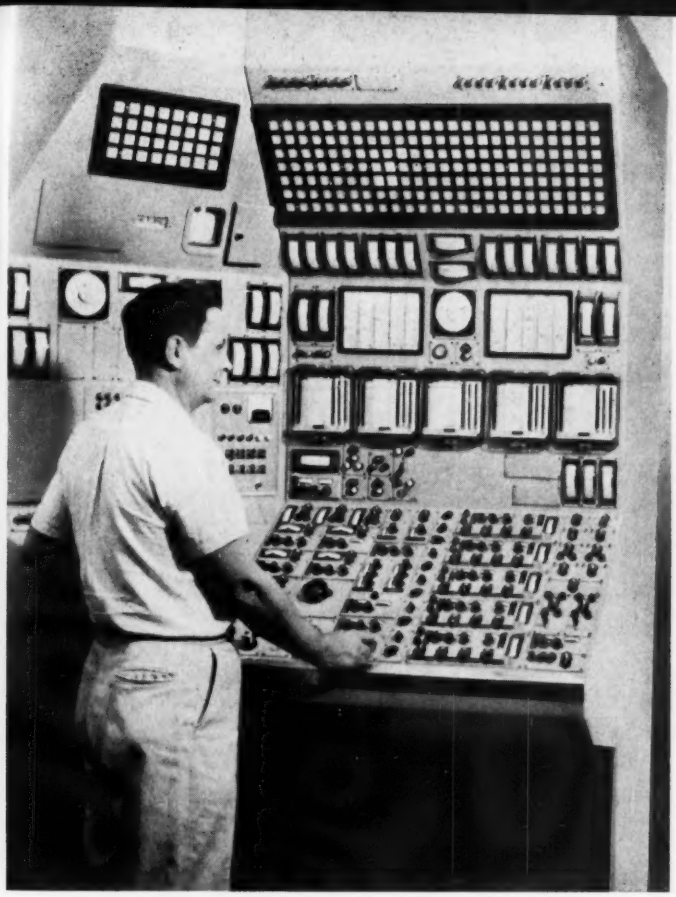
Most designers favor the closed control room with separate air conditioning and soundproofing. Arrangements vary from enclosed ventilated control rooms to control areas where the boards are grouped in a convenient open plant space. Proponents of the latter scheme feel the operator is more alert when he can hear the plant equipment running as well as watch the instruments. Usually a closed air-conditioned telephone room or booth is provided for the operator in the control area.

Plant reliability

Reliability and safety depend on the protection and manning of the control room and plant. Some utilities take pains to make the control room tenable by operators if the plant should fill with smoke by placing ventilating-air intake for the room at the least-hazardous point in the plant wall and pressurizing the air in the room. Others do not take this precaution but take air from inside the plant for forced ventilation of the room—this may be supplemented by a separate outdoor-air intake for use in fire or smoke emergencies.

Using noncombustible insulation on wiring promotes fire prevention in some control rooms. Another method installs fire barriers between panel sections. Some control rooms have automatic CO_2 systems for fighting fires. Fire protection includes concrete-block walls for the control room. Number of openings is cut to a minimum, with fireproof doors. Trenches around fronts of oil-burning boilers drain away accidental leakage to prevent flow to control-room area. Keeping all plant equipment from beneath a control room limits the fire hazard.

Many designers avoid bringing high-voltage and pressure connections into the control room. Converters and transducers mounted at panels next to major plant equipment change primary pressures and voltages into pneumatic or l-v electrical impulses that are brought into con-



Compact board for one unit uses miniature instruments, controls

Control board covers one unit with another board for general station equipment at 45-deg angle at left. Board for second unit will stand to left of operator, at right angles to first unit's board for compact layout

trol-room boards. But som edesigners feel this trend has gone too far for the cost involved. They find that some h-p connections can be brought in safely at the advantage of lower first cost, lower maintenance cost, easier and less-frequent calibration procedures. H-p lines may be brought in through double-wall construction; then the panel interior may be protected by heavy walls and venting to atmosphere to prevent steam entering control room.

Growing unit capacities give utilities serious concern about amount of equipment supervised from one control room. While some 4-unit rooms are used in existing plants, most thinking favors controlling only two units from one room. This limits potential capacity outage during troubles and insures better system reliability.

With 600- to 800-mw units each unit will probably have its own control room. One advantage of only one or two units per room: connecting lines are minimum length to reduce exposure hazard and raise reliability.

Operators per shift in the modern plant vary from two to three per unit. In addition there is a watch engineer for the plant. In the minimum setup, one operator runs the control room and the other roves through the plant on inspection and handles local controls during startup and shutdown. When using three operators, the extra man would be either a second roving operator or a mechanic. For 1-unit plants most utilities keep two operators in the control room, so one man will always be present when the other has to be absent momentarily or becomes ill.

Control-room lighting

Control-room lighting has remained fairly standard over the last decade. Either lighting troughs or luminous ceilings are used with egg-crate or plastic diffusers. Some operators find high lighting levels uncomfortable to the extent that they turn some of the tubes off when on watch. At least one utility calls for improved lighting design to minimize the need for frequent cleaning and maintenance.

Closed-circuit television

Experience with television in the control room has been mixed. It is being used on boiler gages, furnace viewing, stacks, plant security, coal handling and furnace-slag tap. Some operators report dissatisfaction; a few have discontinued TV because of high maintenance.

Data recording or logging

All designers express interest in data logging and some see the day when it will replace the time-tried recording instrument. But present costs of automatic loggers deter many utilities from taking the plunge now. Others feel that the advantage of coupling the logger with the computer for continuous heat-rate monitoring may make the combination pay off in a short time.

What will automation do to the control room?

When considering automation, designers come up with a variety of predictions for the future. The more conservative visualize a computer supplemented by a manually operated control board of the miniature variety. The single operator in the plant would be an engineering graduate versed in the mechanical, electrical and electronic aspects of the generating plant of tomorrow.

At the other extreme some designers predict that plants will be completely automated through computers and other devices. Plants will be unmanned, regardless of capacity, and taken in and out of service and loaded by simple pushbutton command in the system dispatcher's office. The "control room" would be a cabinet in the plant housing the electronic equipment. Plants would be inspected periodically by central maintenance crews roving the system.

At least three plants are now being automated, and many others are trying out the idea via data loggers, heat-rate computers and electronically controlled subloops as the first step to the future thermal-electric plant.

Acres of air conditioning: a fresh approach to industrial systems application shows how you can...

Save cooling dollars with multipackage system

By C R HAVIGHORST, Senior Technical Editor
McGraw-Hill World News, Los Angeles

Many recent technical-society papers and magazine articles have discussed relative economics of multiunit versus centralized-system air conditioning. Apparent result: an impression that the many-small-units philosophy is too costly for large air-conditioning installations. Operating under this impression, many design engineers did not bother to investigate the relative economics for themselves, simply saying, "multiunits won't pay."

"Not so," replied one industrial plant, and produced cost-analysis figures to prove their point. Take a look at these figures. You may want to keep them in mind when asked to specify future industrial-plant air-conditioning systems.

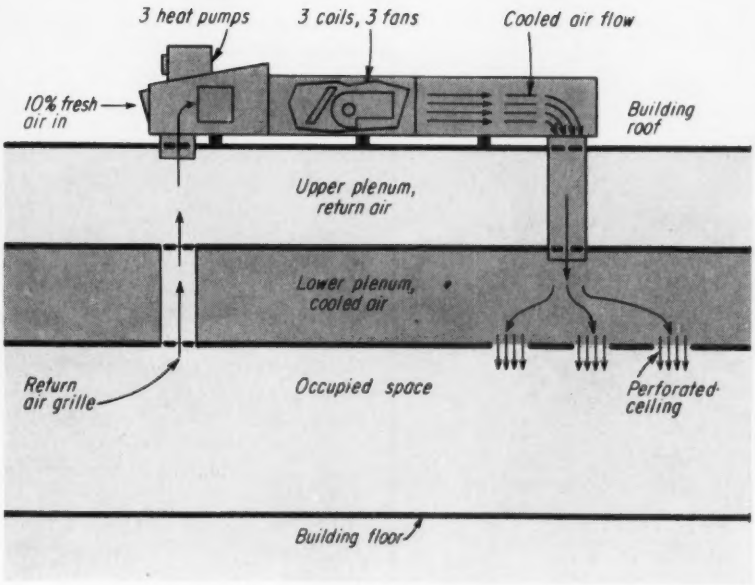
Our analysis begins with a modern 1-story industrial building, the Computer Systems Laboratory of Litton Systems, Inc—a division of Litton Industries, Inc. Situated in Woodland Hills, a part of California's San Fernando Valley area, the sprawling lab sizzles under summer heats up to 117 F and must cope with frigid mid-30 temperatures during winter months. Year-'round air conditioning must provide human comfort, also meet the demands of electronics operation and manufacture. Given these basic requirements, Litton engineers came up with an unusual air-conditioning system to afford maximum system flexibility, excellent regulation and reasonable first cost.

Multipackage system, which turned out to be the biggest installation of its kind, was designed to maintain a uniform 71 F throughout the 180,000-sq-ft building. Careful design permits a uniform temperature differential between floor and ceiling of 1 to 2 F. To obtain required comfort and manufacturing conditions in the Valley's climate, Litton elected to use heat pumps—99 of them, grouped by 3's into 33 separate systems.

With a 1-story building to deal with, heat pumps mount on the roof and require very little ductwork. This is standard for a modern structure. The only problem was one of achieving temperature uniformity; this was solved by using a perforated-tile ceiling and double-plenum system, above right, to assure draft-free air distribution.

Half of the acoustical ceiling tiles which form the floor of the lower plenum are solid. The other half, with adjustable ½-in.-long 1/16-in.-wide perforations, may be made larger or smaller to balance zone temperatures by regulating cfm of air delivered to each area. Perforated T-bars support the solid ceiling tiles, supply cool air to assembly and shop areas. In no case does the air travel more than 60 ft in occupied zones, assuring efficient use of the heat pumps.

Air flows through ducts from the heat-pump systems, down through the upper return-air plenum to the



Dual plenums cut ductwork, increase control flexibility

Heat pumps and fan-coil units mount on building roof so they're placed directly above centers of air-conditioning load. Short and uncomplicated ductwork connects heat pump with occupied area by way of the two plenums. Both plenums are suspended by steel cables from the building superstructure.

Vertical division plates in plenums isolate individual areas for each heat-pump system. Area air flows vary from 400 to 1000 cfm, according to size of zone. Future plant modifications can be handled by adjusting or relocating perforated panels. Major changes would involve moving heat pumps to new roof locations and repositioning some ducts.

lower air-supply chamber. Lower plenum is divided into separate sections corresponding exactly with the occupied zone they serve. The largest zone is an office module 176x60 ft, the smallest 60x60 ft.

Return-air ducts draw air from occupied areas through the supply plenum, into the upper return chamber. Suction of heat-pump fans draws this relatively cool air through refrigerated coils and, with the addition of 10% outside air, returns it to the lower plenum, thence to occupied zones.

Dual-plenum systems and heat pumps supply all but a small part of the total cooling load. One exception is the computer area. Because the computer generates considerable heat, air conditioning here is supplemented with a 20-ton water chiller.

System load was figured for standard conditions of 95-F dry bulb outdoors, 67-F wet bulb entering the evaporator. Each individual heat-pump and fan-coil unit was rated at 9¼ tons of refrigeration and 4000-cfm air flow. Each of the 33 heat-pump systems then produced about 27¾ tons of refrigeration, handled about 12,000 cfm of air. Total heat-pump load rating is 915¼ tons. Add computer-room chiller capacity of 20 tons for a plant total of 935¼ tons—this load also represents 396,000 cfm of air.

Electrical load in plant divides about evenly between heat pumps and other plant uses. Total heat-pump load is 1972 kva, 19.92 kva per pump. Total plant connected load runs about 3850 kw.

Computer-room chiller unit demands 31.55 kva, so total air-conditioning load is 2003.55 kva. Since conditioning is decentralized, the electrical-distribution system handles both pumps and manufacturing load with common systems. Power enters the plant at 4160 v, is reduced to 480 v or lower. The large, multipurpose building is divided into quadrants, each boasting its own 1000-kva substation and dc power source.

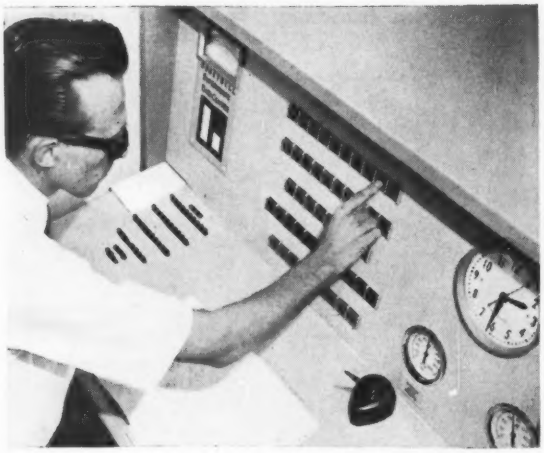
Load fluctuations are typical of this type of combined office-manufacturing-lab building. Heat-pump load peaks at 1972 kva, ranges down to a low of 380 kva. Peaks occur around 4:00 to 5:00 am, 2:30 to 3:00 pm under average conditions.

Capital investment in this packaged system does not exceed that of a centrally located single compressor or absorption heat-pump installation, Litton estimates. Based on average cost per ton of refrigeration, a rough estimate of $700 to $800 per ton for the multiunit system compares quite favorably with that of single absorption machine or compressor setup, estimated at around $1000 per ton. But extras such as the two plenums, a $40,000 supervisory data center and perforated, acoustical tile ceiling keep cost of the packaged installation about equal to the other systems.

Actual costs: distribution system including ceiling and plenums, $305,000; heat pumps and their accessories, $438,000—a total of $743,000. Using our $1000-per-ton estimate, a comparable central system would cost some $935,000.

Multiunits won Litton's vote on the basis of economy and desired operation characteristics. Operating cost is estimated at least 25% less than a central heat-pump system. Under normal temperature conditions, multiunit design provides a safety factor. Failure of one unit temporarily shifts the load to the other two contained in that group.

Supervisory data center cuts maintenance time 50%, permitting one maintenance man to serve two



Supervisory data center speeds multiple-unit troubleshooting

Maintenance of a 99-unit heat-pump system could be so complicated it would cancel a sizable cost differential between central and multiunit systems. But using the supervisory data center as a maintenance tool, specific trouble area and general cause of failure can be spotted without touring the entire roof.

Data-center lights indicate unit in trouble, probable cause of failure. Also, buttons on console deck permit remote reading of temperature and other operating data, automatic start or stop of equipment. Panel includes dial indicators, buttons and lights for air and water pressures, other plant services.

Litton plants. Without the center, time would have to be allowed for him to search 33 heat-pump systems for each mechanical failure. Each system is composed of three heat-pump units, three automatic defrosting-coil and fan units, for a total nine motors ranging from fractional to two hp. So the grand total of 297 motors in these systems would more than complicate his problem of isolating trouble spots.

Pushbutton troubleshooting makes this multiunit system practical. Operating data is not available as yet, but the supervisory data center, above, is highly appreciated as a time-saver and an aid to heat-pump maintenance. Not only can the single man diagnose and pinpoint malfunction of any one of the 33 heat-pump systems, he may also monitor room temperatures, water and air pressures and the operation of four motor-generators supplying dc power.

Of the center's six horizontal banks of lights, the upper four are zone lights. Each light is half red, half green, keyed by numerals to the 33 zones. Extra lights will handle future expansion.

Green panel lights indicate the heat-pump systems and other units are operating properly. In case of malfunction, the green light shuts off automatically, the red zone light switches on, an electric horn sounds a warning. Advised of the zone number, the maintenance man determines kind of malfunction and specific unit out of order. This lets him choose the proper tools for repair work and go directly to the equipment needing attention.

Lower two banks of lights are labeled to designate specific malfunctions of equipment. Top row indicates high head pressure, low suction pressure of heat pumps; cfm output of fans; fan failure; hot motor bearings. Bottom bank of lights discloses malfunctions of the four motor-generators — motor-bearing temperatures, battery discharge— and in addition overhead and underfloor temperature and humidity in the computer zone. Also located on the panel: a gage to measure room temperatures and two water-pressure gages for sprinkler and domestic water supplies throughout the plant.

Each button on the computer's sloping panel or deck is keyed by number to its individual zone light. Operator may activate any one of the 33 troubleshooting circuits by pressing the button corresponding to that of a zone light. Two of the square buttons are used to determine zone temperatures, two are for unit-stop unit-start and the other two measure water and air pressures. Temperatures of supply air, cold-air discharge and outside air may be measured from this panel.

Principal plant equipment

Heat pumps, 99—The Carrier Corp, supplied by Prentiss Corp, Los Angeles, Calif.

Ductwork fabricated by Air Conditioning Co, Los Angeles, Calif.

Perforated acoustical tile—Airson Co, Inc, Milwaukee, Wis.

Supervisory data center—Minneapolis-Honeywell Regulator Co

Heat-pump installation — Kilpatrick and Co, Los Angeles, Calif.

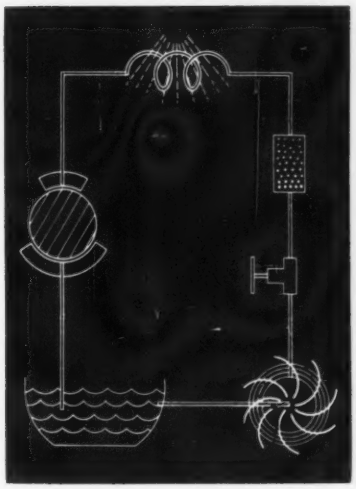
Plenum and ceiling installation—R E Howard Co, Los Angeles, Calif.

Arthur Gibeaut—in charge of facilities, planning and construction

This article starts a series on industrial circulating-oil lubrication systems. Later installments will cover system components in detail —reservoirs, piping, coolers, pumps, filters, control and maintenance. But first let's take an overall look at the design approach to . . .

Forced-circulation oil-lubrication systems

By E R BOOSER and D A SMEATON
General Electric Company



OIL-LUBRICATION SYSTEMS combine many components into a functioning whole. Each part has its own definite job to do in preparing the lubricating oil for reuse

When equipment components are closely associated in operation or location it's only logical to design a common lubrication system for them. Since many more economies are possible than small individual systems can offer, you can afford to build in a higher degree of reliability. But such an integrated system must adequately meet the requirements of all equipment served — and these can vary widely. Major components of an integrated forced-circulation oil-lubrication system will be discussed later. For now, let's take a look at the overall system and its needs.

A basic system begins with the fundamental requirements of flow and heat transfer. Oil's condition on return dictates dwell period in the sump or reservoir. Dwell period in turn determines quantity of oil in the system. From these the system evolves according to three underlying factors that guide design of any integrated system: (1) environment (2) oil function (3) reliability.

Environment means considerations outside the oil system, such as air temperature and the presence of contaminants. High ambient temperatures may impose high heat-transfer problems, requiring one or two stages of coolers. High surface temperatures at delivery locations create the hazard of oil ignition on exposed surfaces. Contaminants may demand an elaborate oil-treatment system to guarantee purity. Separation of machine components or distance from service to storage areas may require oil transfer over comparatively long distances.

Function is the job the oil must do—in many cases a multifunction. It may be practical and economical to use the lube oil for hydraulic-system fluid, coolant or as a special sealant in hydrogen-cooled generators.

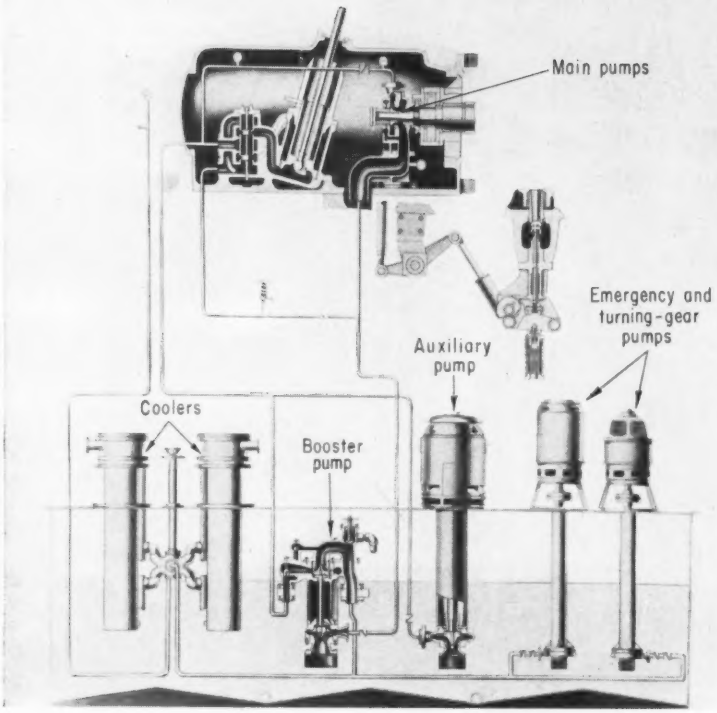
Reliability is the factor which really justifies the system, a requirement inherent in all applications. It adds to system complexity—duplication of essential facilities or extra protective instrumentation and controls may be required.

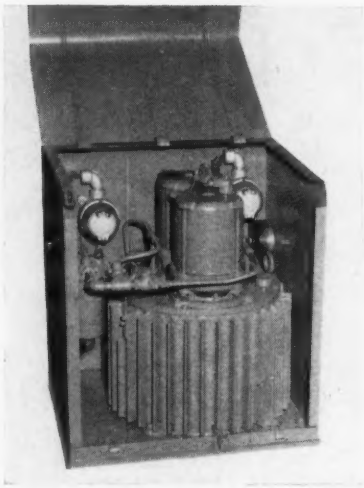
So factors of environment, oil function and reliability are superimposed on your fundamental requirements to create individual system characteristics. In addition, complexity should reflect the investment value jeopardized by any failure of the oil supply. Where multimillion-dollar steam-generators are at stake, utmost in oil-system refinement and sophistication is no more than economic insurance.

Let's look at extremes in terms of needs and complexity to show the gamut of forced-circulation oil-lubrication systems in common use today.

Motors, generators and other rotating electrical machines—a 1250-hp 3600-rpm totally enclosed fan-cooled motor for centrifugal-pump service, for example—normally need only the simplest system. The packaged system on next page includes two 1-hp immersed-gear pumps driven by ac motors and mounted in a 10- to 15-gal reservoir. Where ambient temperatures are high, cooling coils mount in the reservoir itself. Pumps have check valves on their delivery side to permit either one to supply the lubrication system if the other fails. Excess oil spills back into the reservoir through an adjustable relief valve. A self-cleaning filter provides full-flow filtration of the lubricant.

Supply is at 10 to 20 psi through orifices to the motor sleeve bearings; return flows by gravity from each bearing housing through visual indi-





PACKAGED LUBE SYSTEM for motors or generators combines all necessary components into a single unit. Design can be standardized for convenient application

TURBINE-GENERATOR LUBE SYSTEM also provides control oil for turbine governor and hydrogen seals. Several backup pumps insure the ultimate in system reliability

cators. Total flow ranges from about 1½ to 6 gpm in this arrangement.

An oil system relying on a shaft-mounted positive-displacement pump is another common arrangement. Aside from the pump drive, this is quite similar to the packaged lubrication system illustrated, above, right.

Steam-turbine-generator systems contrast sharply to the simple setups for motors—they are perhaps the most complex application of forced-circulation oil lubrication. Schematic at left is typical for a 100-mw unit. System uses 150-ssu oil for three fundamental services: (1) Bearing lubrication includes heat removal from sleeve and thrust bearings. (2)

Lubrication requirements can be classified by machinery type to show approximate

Application	Oil		Main pump				Reservoir		Filt
	Duty	Viscosity, ssu at 100 F	Type	Drive	Delivery, gpm	Discharge, psig	Volume, gal	Dwell, min	
Electric machinery	Bearings	150-300	Gear	Motor or shaft	5-10	10-20	5-10	5-10	Fu
Steam-turbine-generators									
10,000 kw	Bearings and control system	150	Centrifugal	Main shaft	250	150	1000	5-7	By
100,000 kw					300	180-200	2000	7-10	10
300,000 kw					900	180-200	4500	5-7	
Steel rolling mill	Bearings	1000-3000	Gear	Motor	50-225	50-65	2000-5000	20-40	Fu
Gas turbines									
5000-10,000 kw	Bearings and control system	150	Gear	Accessory gear unit	225	55	1200	3-5	By
15,000-22,000 kw			Centrifugal		400	160	2000	5	10
Paper-mill calender stack and dryer section	Bearings and cooling	400-1000	Gear or centrifugal	Motor	30-120	35	3000-6000	40-60	Fu an ce

Hydraulic governing demands that moderate static pressures be maintained during normal operation with provision for high delivery and return rates during load rejection or emergency conditions. (3) Hydrogen sealing involves contamination of the oil by hydrogen in the generator-casing seals. So hydrogen removal from the seal oil returning to the main lubrication system is an absolutely imperative part of the system design.

In such a system, prime mover for the main oil pump is the high-pressure-turbine shaft. Pump delivers into a header which also receives oil from an auxiliary pump, a turning-gear oil pump and an emergency pump. Auxiliary pump is normally motor driven and provides bearing, control and seal oil during startup until the main pump begins to deliver at 60 to 80% of operating speed. During startup, it also provides suction pressure to the main oil pump from the oil reservoir—part of its delivery is diverted to either an eductor venturi or an oil-turbine-driven booster pump. It must be shut down manually but will automatically restart to protect the main turbine when system pressure drops below a given preset level.

Turning-gear oil pump, also ac-motor driven, provides only sufficient oil for bearing lubrication during operation of the turbine turning gear. But it too starts up on system pressure drop and therefore acts as a second backup for the auxiliary pump. The emergency pump, dc-motor driven off the station emergency bus, is the last backup.

All pumps except the main one normally mount on the reservoir with their suctions totally immersed. The reservoir itself is equipped with an ac-motor-driven blower for vapor removal. Since high-pressure turbine-casing temperature may be above flash point of the oil, return-oil piping surrounds high-pressure supply lines to eliminate hazard from any leakage in the supply piping. A separate system circulates generator hydrogen-seal oil. Main oil storage is subject to a continuous 10% bypass filtration. Full-flow oil coolers are mounted directly on the reservoir.

This ultimate in complexity for a 100-mw turbine-generator contains about 2000 gal of oil. The main pump circulates 300 gpm at a discharge pressure of 200 psig. Control oil is used at 200 psig, bearing oil at 25 psig. Hydrogen seals receive their oil at a pressure depending on generator-casing hydrogen pressure.

Paper mills present a special case in forced-circulation oil-lubrication-system design, for here contamination is high. You might think first of dust, dirt or metallic particles, but in paper mills, water is actually the worst offender. Condensation produces some water in any system; here it must be dealt with in large amounts. Steam leakage from dryer rolls, high condensate rates from heated surfaces and the generally wet environment surrounding Fourdrinier and cylinder machines create this severe water-contaminant problem.

To meet the situation and keep water content of the circulating-oil system at a minimum, several special design steps are needed. Reservoir capacity must be high to allow a long dwell period, get good water separation. Supply pump is provided with a "floating" suction to draw in only uncontaminated oil near the surface. Pump delivery is full-flow filtered through automatic filters having a cycled motor-driven cleaning sequence. An essential consideration is rapid water removal by a centrifugal oil purifier which draws oil continuously from the reservoir or settling tank and returns purified water-free oil ready for reuse.

Between these extremes of simplicity and complexity there are many other forced-circulation oil-lubrication systems. Typical ones on the long list might include systems to lubricate large compressors, boiler-feed pumps, coal pulverizers—even your automobile engine. Some are quite straightforward; many, such as the paper-mill application mentioned, present special problems. But their design is always guided by the same three underlying factors: environment, oil function, reliability.

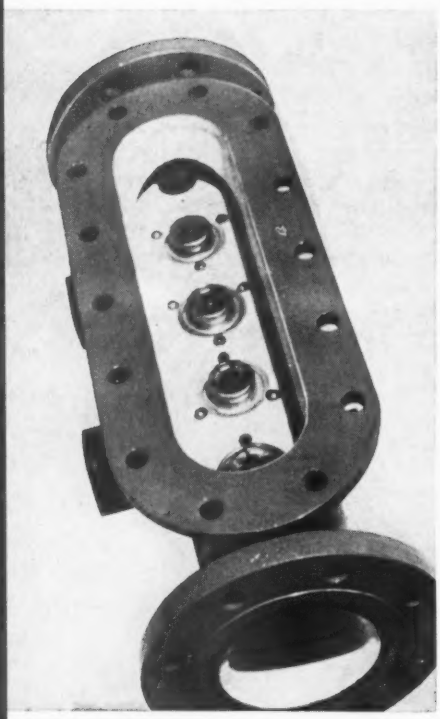
Recent trends in forced-circulation oil-lubrication systems stress simplification, reduced cost and increased reliability. Oil reservoirs are shrinking; pumps and coolers are mounted directly in the oil tanks; auxiliary equipment and controls are being placed on the tank cover plate. And sometimes the whole system is incorporated into the equipment to be lubricated. Example: in many gas-turbine applications, the oil tank is a part of the base of the unit itself; oil-return ducts are fabricated as sections of structural members. This integration of oil-circulation system and machine offers advantages in lower initial cost and reduced space needs.

Safety and reliability are getting a hard look. Use of nonflammable oils will likely extend rapidly as their performance is established and formulation standardized. With this will come suitable paints, electrical insulation and gaskets. Guarded high-pressure oil lines are already in common use around steam and gas turbines to reduce fire hazard. Auxiliary pumps driven from auxiliary power sources will permit shutdown after power outages or equipment failures with a minimum of damage to bearings and gears.

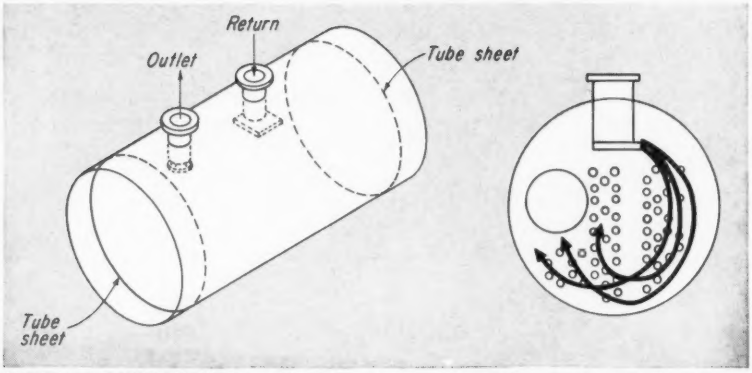
Watch for the next installment in this forced-circulation oil-lube-system series. Next topic in this series: the proper design of oil reservoirs.

needs and system makeup

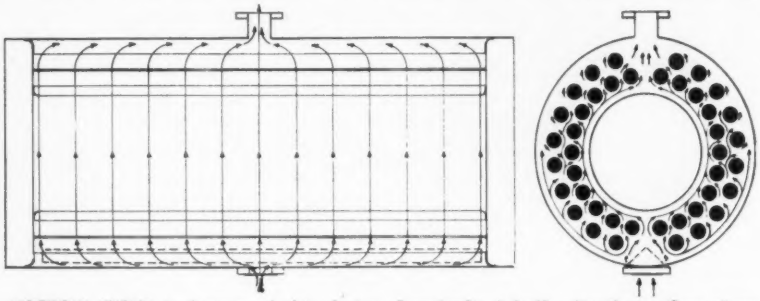
Filtration method	Auxiliary pumps
Full flow	Duplication of pumps in packaged system
Bypass of 10 to 20%	Oil-turbine-driven booster Ac-motor-driven auxiliary Dc-motor-driven emergency Ac-motor-driven turning-gear pump
Full flow	Complete dual systems
Bypass of 10%	Ac-motor-driven auxiliary Dc-motor-driven emergency Oil-eductor booster
Full flow and bypass centrifugal	Ac-motor-driven duplicates



THERMOSTATIC valve device limits return rate to boiler's recuperative capacity



INTERNAL DISTRIBUTION in this design brings returns in at top of boiler, directs water transversely. Flow is downward along shell, then rises to dip-tube outlet at top



BOTTOM INLET is feature of this design. Longitudinal baffle distributes flow along boiler's length. Vertical flow then contacts heating surfaces in travel to top outlet

Forced-circulation hot-water heating-system design involves many factors. An important one: how to . . .

Guard against thermal shock

Parameters of hot-water heating-system design have been established by authorities. Variables such as pump selection, radiation, piping design and arrangement can be properly correlated by the engineer. Selected temperature drop—difference in water temperature entering and leaving the boiler—is a matter of judgment. A widely accepted practice is to assume a drop of 20 F.

Temperature drop in any hot-water system is, however, a variable condition. A departure from the design drop may come with changes in outdoor temperature, system friction losses and other factors. Actually temperature differentials far greater than generally realized do occur, particularly at initial or seasonal startup or where zone circulating pumps operate intermittently. They often occur after extended power failures. These differentials can cause damaging thermal shock in boiler parts.

Thermal-shock stresses can be augmented by stresses from thermal expansion of water if the compression tank is undersized or becomes totally flooded. So it is important that the compression (expansion) tank be properly sized and have no chance to bleed off much of its air cushion.

Three avenues toward thermal shock control exist: (1) boiler designed to safely absorb operating conditions conducive to shock stress (2) system design providing external control to prevent rapid temperature and flow-rate changes in the boiler (3) properly operating and maintaining the equipment.

One boiler manufacturer, convinced that item (1) is the basic approach, conducted a research and development program which produced these data: Actual stresses encountered and maximum allowable stresses

Thermal shock: long-time threat to hot-water boilers

In September 1955, the Packaged Steam Generator Branch of American Boiler and Affiliated Industries teamed up with the Steel Boiler Institute to issue this joint statement concerning thermal shock in boilers serving forced-circulation hot-water heating systems:

"Serious difficulties have been encountered in boilers serving forced-circulation hot-water heating systems when the systems were improperly designed, incorrectly installed or improperly operated. Investigation has shown that as a result there have been cases of thermal shock in boilers.

"The term 'thermal shock' as used here describes a severe stress or series of stresses in a boiler. Such stresses may be violent enough to loosen tubes or crack plates. This particular type of trouble is caused by a rapid temperature change in any part of the boiler. Consequently, heating systems should be designed, installed and operated in a manner which will prevent rapid temperature changes in the boiler water.

"This statement lists a number of details which, singly or together, may result in thermal shock. It has been prepared to help guide those responsible for the design, installation and operation of heating systems so they may eliminate those factors which can result in thermal shock, and thereby minimize possible damage to boilers.

"Experience has shown that the temporary period when the owner's operator is not in attendance may be the one where difficulties most frequently occur.

"The following items should be given particular consideration:

"(1) Temperature of water returned to the boiler. If water returned from the system is considerably cooler than the outlet water during any part of the operating cycle, it is desirable to provide a bypass with means for tempering the return water. The bypass preferably should be arranged to introduce water from the boiler into the return line rather than to circulate part of the return water into the system.

"(2) Rate of flow of return water into the boiler. Select pumps and controls so that water will not flow into the boiler at a rate higher than required to supply heat to the load. Slow-opening valves may be used to control the rate of water flow in those systems where the type of pump is suitable for restricted flow.

"(3) Direction of water flow through the boiler. Do not introduce water through any except the normal return connection without obtaining specific approval of the boiler manufacturer."

The trend in recent years toward an increased use of forced-circulation hot-water systems, as opposed to natural-circulation systems, has spurred research among boiler manufacturers in an effort to minimize factors considered as contributing to possibility of thermal shock. In this article, POWER presents typical avenues of approach used by several manufacturers. We feel they are indicative of the entire industry's genuine concern with overcoming this problem.

can be calculated from test results. Where movement of metal being heated or cooled is restricted, stresses result. Critical points of thermal stress are at the tube joints and in the tube-sheet ligaments between tube holes.

Consider temperature drop through the boiler metal between the combustion and water sides. Effect of dynamic or shock loading on stress, value of stresses induced in the restrained tubes and tube sheets, and tube-joint strength as calculated indicate that a maximum-allowable sudden temperature drop of 45 F in the boiler water will keep stresses below the yield point. A further involvement: the problem of fatigue failure where the boiler metal is alternately stressed and unloaded. Where stresses exceed the yield point, number of cycles required to produce failure drops drastically.

Water tends to rise as it is heated, so natural thermal circulation is from bottom to top. Conventional hot-water-boiler design, in which return water enters at or near the bottom of the boiler, takes advantage of this. But because of high flow rates in forced-circulation hot-water systems, large volumes of cold water returned to the boiler may cause wide temperature differentials.

Reverse-flow design tends to reduce stratification by mixing cold returns with the hottest water at the top. But this flow opposes natural circulation in the boiler. Result: outlet temperatures at the bottom may be significantly higher than the highest boiler-water temperatures.

This manufacturer's newly developed design incorporates internal distribution that provides a natural-circulation flow path down the sides of the boiler, along the shell and up through the center. Both return and outlet connections are at the top of the boiler, upper drawing, first page. The hottest water is taken from the top through a dip-tube outlet and vent connection designed to supply deaerated water to the system. Tests showed that the inlet connection must direct the water transversely, not longitudinally, toward the front and rear tube sheets. High flow rates would cause direct impingement of cool return water against the tube sheets; low velocities would cause returns to drop directly onto the combustion tube, the hottest metal surface to be found in the boiler.

Data were taken from hundreds of tests involving various flow rates, temperature drops and three styles of return-water connections: conventional, reverse flow and the new internal-distribution system. Tests were run on a unit with rated output of 3.347-million Btu per hr, fitted with 46 thermocouples arranged in four bands from front to rear tube sheets and measuring temperatures from top to bottom. Table 1, next page, shows results for four sets of tests. In each instance the table duplicates con-

1—Tests show performance of various return systems

System		Avg boiler temp, start of test	Inlet-water temp, start of test	Max differential in boiler-water temp
Rated capacity	Conventional flow	200	50	107
35 gpm	Reverse flow	200	50	28
150-F differential	New design	200	50	18
Rated capacity	Conventional flow	124	80	33
180 gpm	Reverse flow	120	80	33
38-F differential	New design	122	76	28
200% rating	Conventional flow	155	80	51
180 gpm	Reverse flow	155	80	41
75-F differential	New design	155	80	30
400% rating				
180 gpm	New design	230	80	45
150-F differential				

ditions of a boiler carrying a given load and being shocked by a sudden drop in return-water temperature. Ratings shown are relative to rated output capacity of the boiler.

At 180-gpm flow rate and temperature drop of 38 F—equivalent to 100% of boiler capacity—results indicate that the three systems maintain very nearly the same boiler-water-temperature differentials. Other tests, not tabulated, show that with system drops of 45 F or less the temperature spread in the boilers will not exceed the 45-F maximum-allowable limit at any flow rate.

As system drop rises above 45 F, however, flow rate and, particularly, boiler-return-system type is important. For example, at rated boiler capacity with a 150-F system drop shown in first set of tests, table 1, both the new distribution system and reverse flow provide temperature differentials within the allowable limits. The conventional system, however, produces differentials that appear to eventually lead to thermal-shock damage. The first set of tests for a 35-gpm flow rate with a 150-F system drop, shown in table 1, is a condition often encountered with zoned hot-water heating systems.

Another series of tests was run with a conventional flow system in which hot boiler water was blended with cold returns. Table 2 compares results with those of the new distribution system without tempering returns. Regardless of capacity, at high system differentials, reverse flow appears to produce boiler-water differentials approximately 50% higher than does the new system, though it is more favorable than conventional flow.

Curves, next page, indicate maximum operating limits of the boiler incorporating the new internal-distribution system. One example shows that with a flow rate of 3 gpm per bhp, the boiler operating at 100% rating would handle a system drop of 23 F, produce maximum temperature differential within the boiler of 22 F. If a system differential suddenly increased to 69 F (equivalent to a 300% rating), temperature spread in the boiler would increase to 34 F, well below the allowable 45-F limit.

Another example shows that, operating with a rated capacity of 0.9 gpm per bhp, system drop would be 76 F and maximum temperature differential in the boiler 27 F. Let's triple the pumping rate at the same system drop, follow the system drop coordinate of 76 F to intersection with 300% rating curve at top, then vertically down to 300% rating curve at bottom. This shows temperature differential within the boiler of 34 F.

A second manufacturer, also believing that the answer to thermal shock lies in basic boiler design, evolved the circulation pattern shown in lower drawing, page 72. First step was proving the concept that a boiler designed for steam generation wasn't practical for forced-circulation hot-water service. Saturated water at 212 F has an approximate density of 60 lb per cu ft, a steam-water mixture has a density of 18 lb per cu ft—a difference of 42 lb per cu ft with no temperature change.

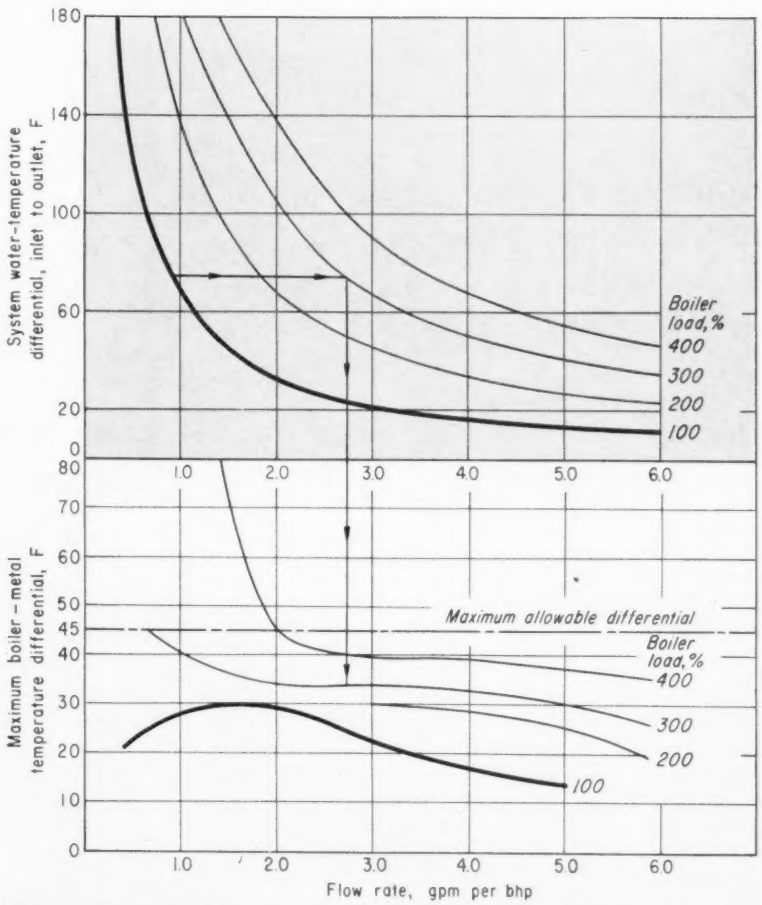
In a normal mixture, 70% steam by volume is used for density calculations. Since steam at 212 F has a density of 0.0373 lb per cu ft, its identity in this calculation is negligible. Water at 212 F has a total heat value of 10,760 Btu per cu ft, steam only 42.9 Btu per cu ft, so water-to-steam ratio is 251. On the other hand, water at 50 F weighs about 62.4 lb per cu ft. At 350 F it weighs 55.5 lb per cu ft for a 6.9-lb-per-cu-ft weight differential — an extreme example, but illustrating why recirculation does not work successfully in a hot-water boiler.

This idea is emphasized when one considers that the average forced-circulation system will normally operate with a 20-F temperature differential and a resulting density differential of 0.59 lb per cu ft. Further, a 2000-lb-per-hr-capacity boiler would require about 245 gph to generate steam at 212 F with feedwater at 192 F. A hot-water generator operating on the same temperature differential would require 12,004 gph to produce the same output. Volume of water required to produce an equivalent Btu output in a hot-water generator is approximately 50 times greater than in a steam boiler.

Design evolved by the manufacturer's engineers places the shell around the main furnace tube and return tubes to eliminate steam space and recirculation area. All water must

2—Compare internal vs external flow control

Test number	1	2	3	4	5
System	Conventional	Conventional	Conventional	Conventional	New design
System flow, gpm	139	132	126	131	142
Recirc flow, gpm	0	54	92	92	0
Outlet temp, start	250	250	250	250	250
Return temp, start	72	130	150	200	77
Inlet-outlet diff, start	178	120	100	50	173
Rating, %	355	332	321	218	350
Max temp diff in boiler	153	122	107	69	60



MAXIMUM ALLOWABLE operating limits of the hot-water-boiler design, top of first page, are indicated by these curves. Temperature differentials are well below 45-F limit

contact effective heating surface in passing from inlet to outlet and, consequently, flow must be vertical. Entering water must flow longitudinally to promote even distribution along entire length of the vessel. This was accomplished by using an internal baffle to cover the inlet opening and extend longitudinally between the two boiler tube sheets.

Theoretically the design appeared practical. To prove it, two units were built for lab tests and subjected to hundreds of hours of severe operation. Temperature changes varied from 2 to 150 F and circulation rates were changed to simulate all conditions which might be experienced in field operation. No difficulties were encountered. Further tests, conducted in accordance with standards established by the ASME testing and rating code, showed that the units performed above 80% efficiency.

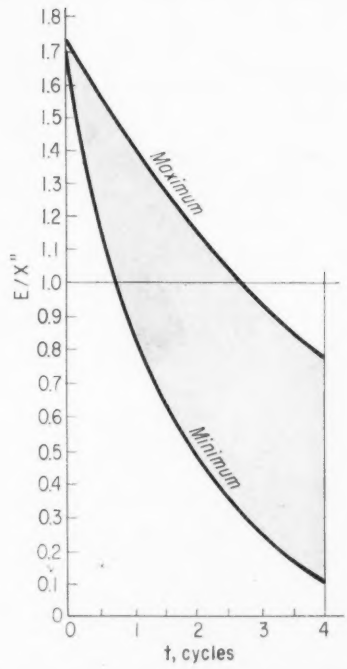
A third manufacturer, in addition to redesigning his boiler, has developed a device to control return flow rate to the boiler. Boiler design, not shown, utilizes a venturi-action and tempering tube internally. Return water mixes with and is tempered by the boiler water.

Newly designed flow-control device, photo, page 72, is intended to approach ideal conditions, maintaining a flow rate which varies inversely as the temperature differential. Device is essentially a simple valve in which a fixed orifice is combined with multiple thermo-balanced expanding valves, number varying with capacity requirements, which react automatically to return-water temperature. This limits return flow rate to the boiler's recuperative capacity.

As the returning water's temperature approaches temperature of the water in the boiler, multiple expanding orifices pass an increasing flow. The device may be installed internally or externally to the boiler and may be used with either conventional or reverse-flow hot-water system.

By A H KNABLE
Allis-Chalmers Manufacturing Co

Just one *E/X* calculation per fault can readily and accurately analyze industrial electric-distribution systems for circuit-breaker application. Method involves a single multiplier developed to simplify . . .



1 Induction-motor fault-current decrement characteristics are first established

Applying medium-voltage circuit

A closer look at circuit breakers

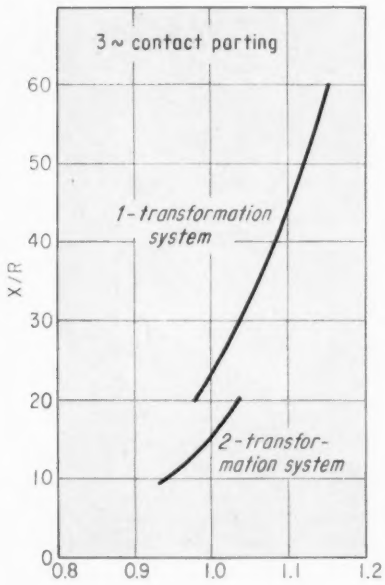
Recent developments in circuit-breaker rating and application (POWER, April 1960, p 101 and Jan 1961, pp 64-67) have spotlighted growing importance of proper protection for today's large loads with high available short-circuit currents. Proposed revisions to the power-circuit-breaker (above 600 volts) Standards of ASA are contained in three AIEE *Transactions* papers: 60-151—ASA C37.3, "Definitions" and C37.4 "Rating structure"; 60-152—ASA C37.5, "Methods for sinusoidal waves" and C37.9 "Test procedure"; 60-153—ASA C37.10, "Application guide." Since papers were first presented, modifications have been made in application guide to simplify and clarify it, make it more useful for industrial electric systems.

AIEE activity in rerating power circuit breakers (for voltages above 600) involves not only revision of the breaker rating structure, but also revamped application procedures. Application guide is provided in revised AIEE *Transactions* paper No. 60-153. This paper suggests an excellent way to apply circuit breakers on utility systems. The work in 60-153, however, concentrates on synchronous machinery as the source of fault current, with minimum attention given the induction-machine fault-current contributions we find in industrial electric-distribution systems. Here induction motors are usually the major load.

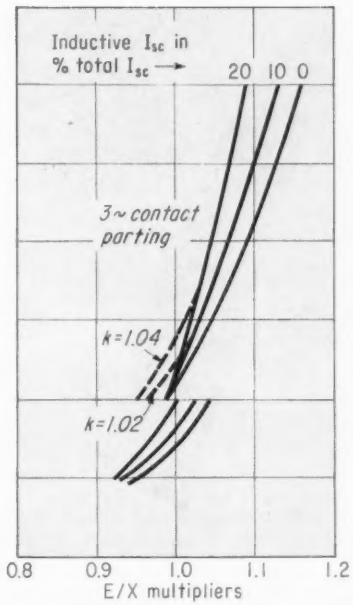
Now let's see how we can help establish a simple and accurate application procedure for medium-voltage (m-v) circuit breakers in industrial systems—we can consider this an extension of the data in 60-153. This paper is the foundation of our discussion because induction-machine fault current is superposed on certain portions of the decrement curves shown in it.

Approach to industrial application of circuit breakers may be outlined as follows:

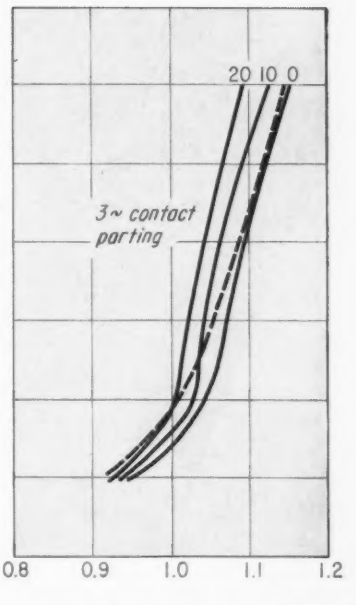
(1) The industrial system can be simply and accurately analyzed for breaker application by *one E/X* calculation



2 Synchronous-machine decrement characteristics, high and low X/R regions



3 Fault currents of induction motors and synchronous machines are superposed



4 Realistic X/R regions are linked to establish application multiplier curves

breakers in industrial systems

per fault. Then all rotating machinery connected in the system is represented by X''_d, the subtransient reactance.

(2) Induction machines should be ignored when determining X/R at the fault.

(3) The order of magnitude of X/R for synchronous-machine and supply-transformer portions of the system can be fairly well established with these items in mind: (a) An industrial system with a supply transformer and only induction machines would have X/R of about 10 to 15, same as the transformer. (b) An industrial system with a supply transformer, 50% induction-motor and 50% synchronous-motor load would have X/R of approximately 20 to 25. (c) An industrial system with its own generation and all-synchronous-motor load would have an X/R of about 30 to 35.

(4) E/X multiplier curves based on both the momentary and interrupting values of fault current allow breakers to be very simply applied by *one* multiplier.

(5) Multipliers proposed for breaker application are given in table, Fig. 6.

Superposition of induction-motor fault current on synchronous-machine fault current simplifies the breaker-application problem—induction-motor X/R or decrement does not have to be considered when using the E/X multiplier curves developed for the approach we are discussing. Development of these curves might be considered in four steps (represented in the illustrations above):

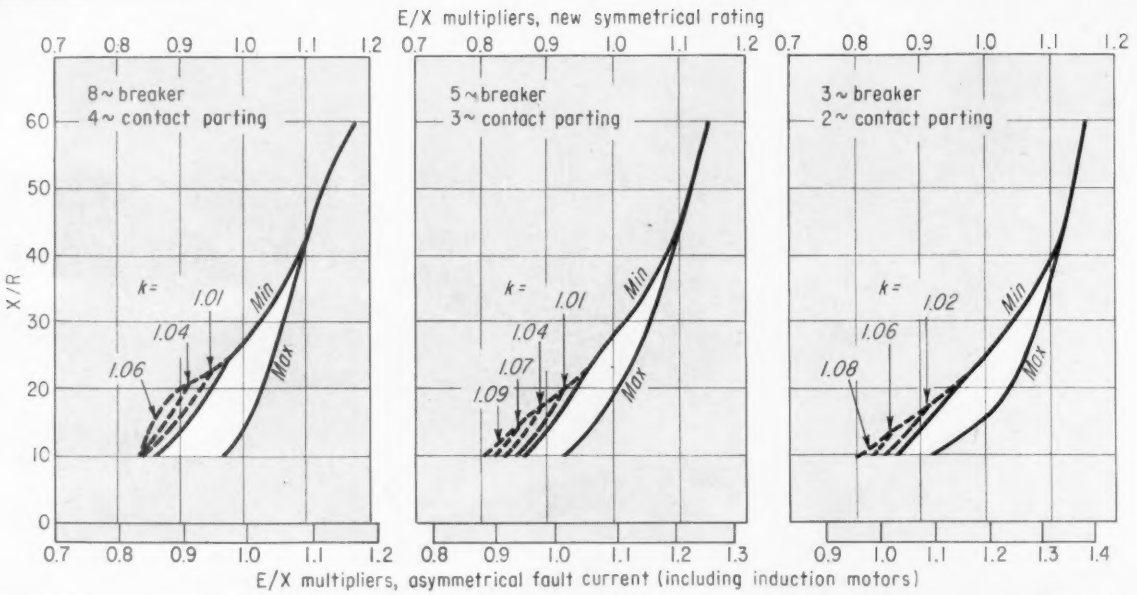
(1) Establish the induction-machine decrements, *maximum* for large high-speed machines and *minimum* for small slow-speed machines, Fig. 1.

(2) Establish the synchronous-machine decrements, a high-X/R-region characteristic and a low-X/R-region characteristic, Fig. 2.

(3) Superpose the induction-machine fault-current decrements on synchronous-machine fault-current decrements. In turn, 0, 10 and 20% of total fault current are considered as coming from induction machines. Momentary limitation k of the breaker is also indicated at this stage, Fig. 3.

(4) Join the realistic high-X/R region with the realistic low-X/R region to establish E/X multiplier curves to be used in breaker application, Fig. 4.

General approach used is illustrated in Fig. 1 to 4. Fig. 5 represents results for 8-cycle, 5-cycle and 3-cycle



5 *E/X"* multiplier curves are for symmetrically rated circuit breakers applied to industrial systems. Scale at lower edges gives multipliers for asymmetrical fault current including contribution of induction motors. 8-, 5- and 3-cycle breakers are shown

breakers with maximum and minimum induction machines present in the industrial-distribution system.

Other factors are involved. Line-to-ground faults were not considered since the majority of industrial systems have impedance to ground, limiting ground-fault currents to well below the breaker rating. Only 3-phase faults were considered in the application curves.

Effect of cable impedance is not considered since fault calculations will be required in many instances where the amount of cable is unknown. Cable has an X/R of about 1, so cable in the system reduces the dc decrement, lowering the total fault current even though the E/X calculation may not be reduced much—see examples 2 and 3.

Delayed circuit-breaker tripping was not introduced into the application curves. Since interchangeability of circuit breakers in a lineup is desirable, and since relay settings used are not always known when fault calculations are made, establishing delayed-trip multipliers would probably not be a good idea.

Momentary and interrupting limitations both must be known for proper breaker application. The momentary limitations are defined by *k*-factor curves shown in the E/X multiplier graphs. A simple graph, Fig. 7, may best depict meaning of k = system voltage ÷ minimum breaker-rating voltage. Small k should not be confused with large K = maximum rated voltage ÷ minimum rated voltage which is presented in 60-153 as part of the breaker rating structure. Note that *voltage range factor K* is constant regardless of voltage of the system on which the breaker is applied, while small *application k* varies with voltage of the system on which the breaker is applied. Role of small k may also be recognized in Fig. 6.

How old method of rating compares with new

Old rating

Momentary kiloamp	Maximum kiloamp	Asym mva	Rated kv	Maximum design kv	Minimum kv at rated mva
60	37.5	250	4.16	4.76	3.85

For 8-, 5- and 3-cycle breakers, asymmetrical interrupting capability = 1.0 x 37.5 kiloamp, 250-mva asymmetrical, where:

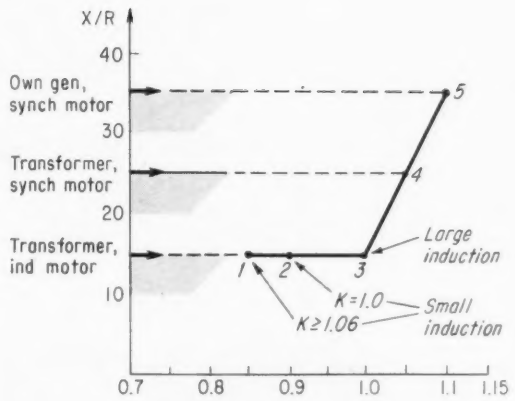
$$\text{Asym interrupting kiloamp} = \frac{\text{maximum kiloamp rating x min kv rating}}{\text{system kv}}$$

New rating

Momentary 1.6 x K x rated I_{sc}	K x rated I_{sc} (max sym int)	Rated I_{sc} at max voltage	Sym mva	Nominal kv	Max design kv	Voltage range factor K	4.76 × 1/K
60 kiloamp	37.5 kiloamp	30.2 kiloamp	250	4.16	4.76	1.24	3.85

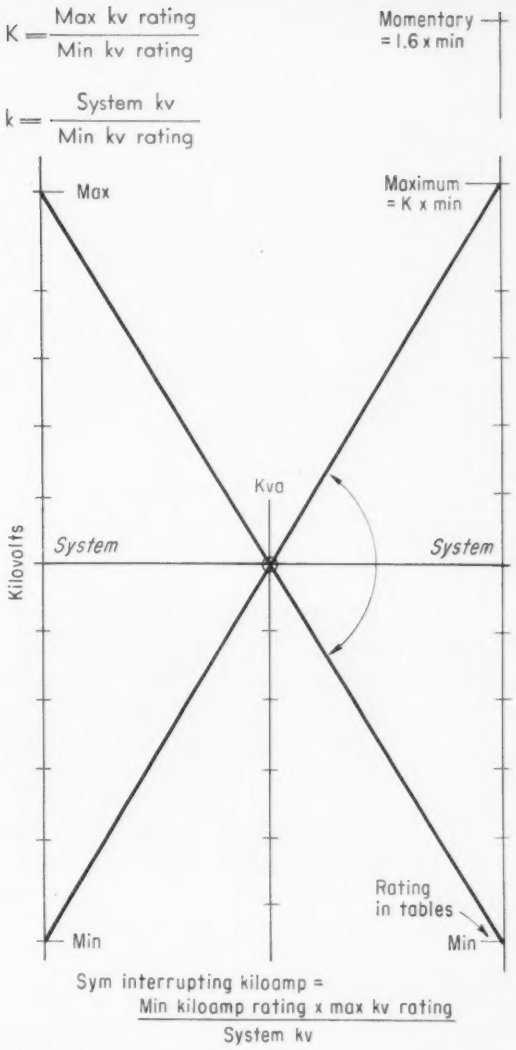
Asymmetrical interrupting capability:
for 8-cycle breaker = 1.0 x 37.5 kiloamp, 250-mva asymmetrical
for 5-cycle breaker = 1.1 x 37.5 kiloamp, 275-mva asymmetrical
for 3-cycle breaker = 1.2 x 37.5 kiloamp, 300-mva asymmetrical, where:

$$\text{Sym interrupting kiloamp} = \frac{\text{min kiloamp rating x max kv rating}}{\text{system kv}}$$



Source	Approx X/R	Breaker multiplier
Power transformer		
Small ind motors K≥1.06	15	0.85
Small ind motors K=1.00	15	0.90
Large ind motors	15	1.00
Synch motors	25	1.05
Own generator	35	1.10

6 Proposed multipliers for 8-, 5- and 3-cycle breakers are practical for industrial systems. Note use of the small k factor

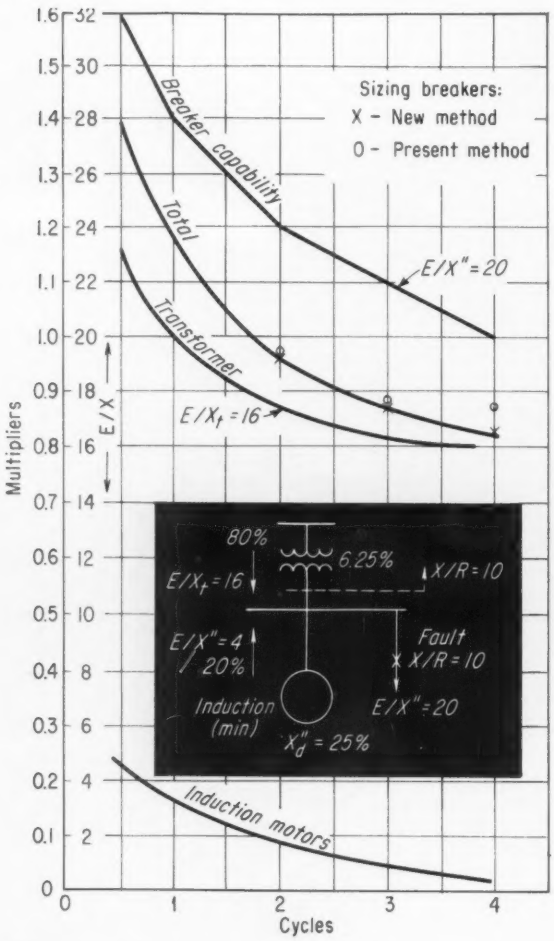


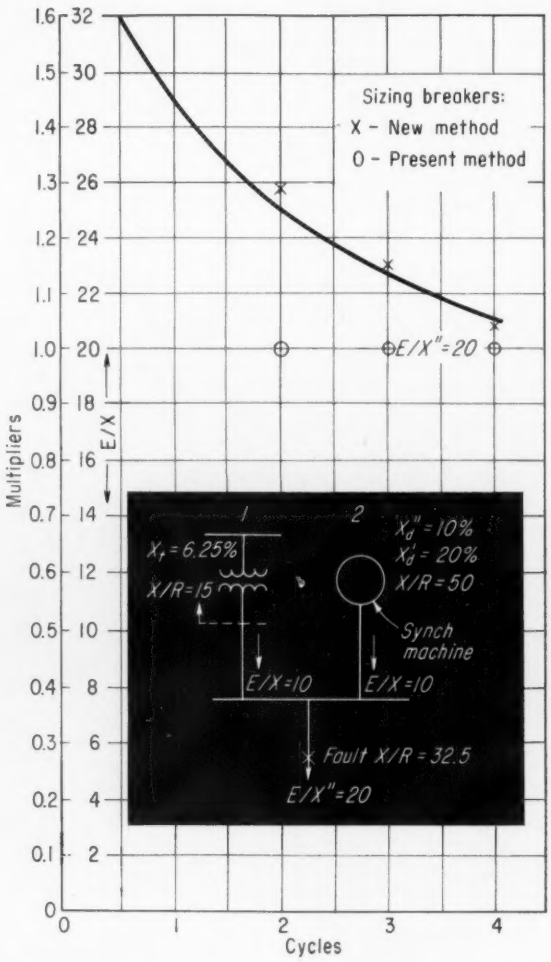
7 Meaning of k factor is here defined in terms of minimum voltage rating. Don't confuse with K derived from rating structure

Sample calculations for four typical application problems . . .

Four examples of breaker application on following pages show that in general you should take these steps: (1) Make conventional E/X calculation representing all rotating machinery by its subtransient reactance X''_d. (2) Establish system X/R at the point of fault, ignoring influence of the induction-motor load. The system X/R can be calculated (or estimated as you gain experience). A useful relation: in series X/R combinations, smaller-mva component dominates; in parallel combinations, larger-mva component dominates. (3) From Fig. 6 obtain approximate multiplier for E/X calculation; multiply to get required symmetrical breaker rating adequate for both interrupting and momentary duty. **continued**

. . . illustrate both application procedure and validity





Example 1

A small industrial has all "minimum" induction-motor load. Note that for this type of system, momentary current truly exceeds interrupting current by more than the 1.6 multiplier

By new method of calculation:

4-cycle contact parting		**Momentary requirements**
20 x 0.86 = 17.2	$k = 1.00$	27.6/16.6 = 1.67, fault
20 x 0.83 = 16.6**	$k = 1.04$	1.6/1.0 = 1.6, breaker
16.6 x 1.0* = 16.6 = I_{sc}		1.67/1.6 = 1.04, k required
3-cycle contact parting		
20 x 0.86 = 17.2	$k = 1.00$	27.6/16.4 = 1.58, fault
20 x 0.79 = 15.8**	$k = 1.09$	1.6/1.1 = 1.45, breaker
15.8 x 1.1* = 17.4 = I_{sc}		1.58/1.45 = 1.09, k required
2-cycle contact parting		
20 x 0.86 = 17.2	$k = 1.00$	27.6/19.2 = 1.44, fault
20 x 0.80 = 16**	$k = 1.08$	1.44/1.33 = 1.08, k required

* Breaker built-in capability ** Breaker rating

Example 2

An industrial system has about 30% of its own generation and for practical purposes all synchronous-motor load. No cable was included. The momentary is no limiting factor in this example

$$X/R \text{ at fault} = \frac{X_1(X/R)_2 + X_2(X/R)_1}{X_1 + X_2} = \frac{10 \times 50 + 10 \times 15}{20} = 32.5$$

By new method of breaker calculation:

4-c cp	20 x 1.04 = 20.8*	20.8 x 1.0 = 20.8 I_{sc}
3-c cp	20 x 1.04 = 20.8*	20.8 x 1.1 = 22.9 I_{sc}
2-c cp	20 x 1.07 = 21.4*	21.4 x 1.4 = 25.7 I_{sc}

By present method of calculation:

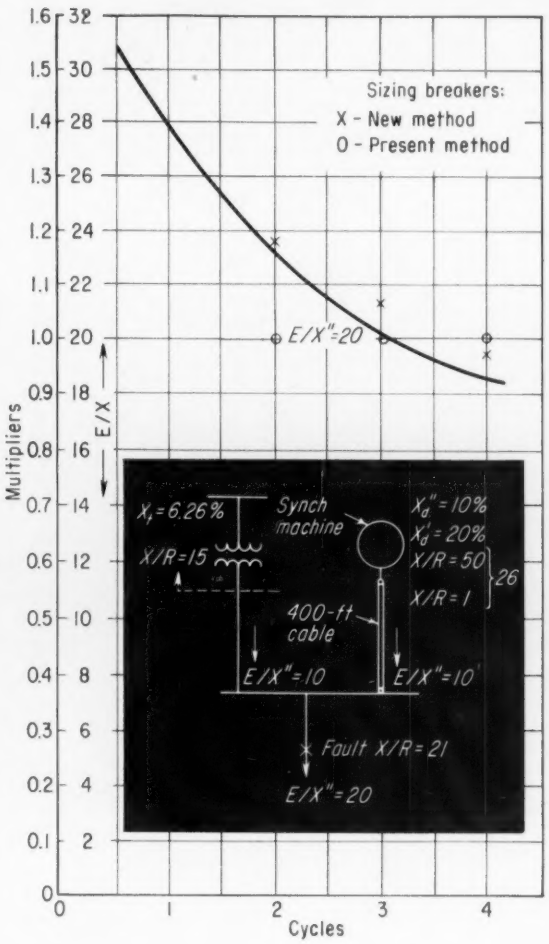
Momentary = 20 x 1.6 = 32

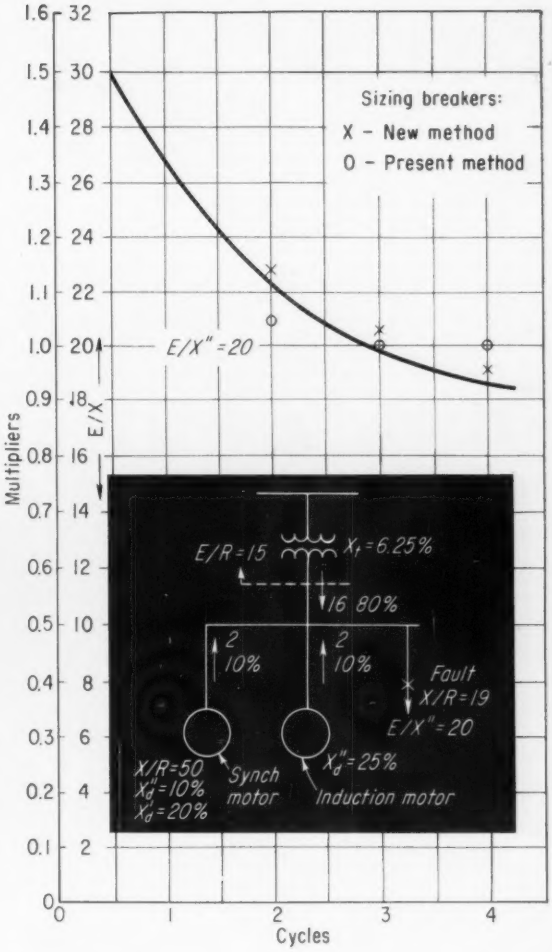
	Calculate interrupting:	Check momentary:
4-c cp	16 x 1.0 = 16	$\frac{32/16}{1.6}$ = 1.25, therefore 20
3-c cp	16 x 1.1 = 17.6	$\frac{32/17.6}{1.6}$ = 1.14, therefore 20
2-c cp	16 x 1.2 = 19.2	$\frac{32/19.2}{1.6}$ = 1.045, therefore 20

Note that present method of calculating interruptions shows interrupting current less than actual; momentary appears greater than 1.6

*Breaker rating

of the approach we have developed





Example 3

Same system as Example 2, except that 400 ft of cable to all synchronous machinery is included. Adding cable to the problem means the momentary becomes a limiting factor

By new method of calculation:

4-cycle contact parting	**Momentary requirements**
20 x 0.97 = 19.4	31/18.6 = 1.67, fault
19.4 x 1.0 = 19.4 = I_{ac}	1.6/1.0 = 1.6, breaker
	1.67/1.6 = 1.04
3-cycle contact parting	
20 x 0.96 = 19.2	31/20.2 = 1.53, fault
19.2 x 1.1 = 21.1 = I_{ac}	1.6/1.1 = 1.45, breaker
	1.53/1.45 = 1.06, *k* required
2-cycle contact parting	
20 x 0.97 = 19.4	31/23.2 = 1.34, fault
19.4 x 1.2 = 23.3 = I_{ac}	1.6/1.2 = 1.33, breaker
	1.34/1.33 = 1.01, *k* required

By present method calculations are the same as for Example 2

Example 4

An industrial system has about 65% "minimum" induction-motor load and 35% synchronous-motor load, supplied by power transformer

By new method of breaker calculation:

4-c cp	20 x 0.95 = 19.0*	19.0 x 1.0 = 19.0 I_{ac}
3-c cp	20 x 0.93 = 18.6*	18.6 x 1.1 = 20.5 I_{ac}
2-c cp	20 x 0.94 = 18.8*	18.8 x 1.2 = 22.6 I_{ac}

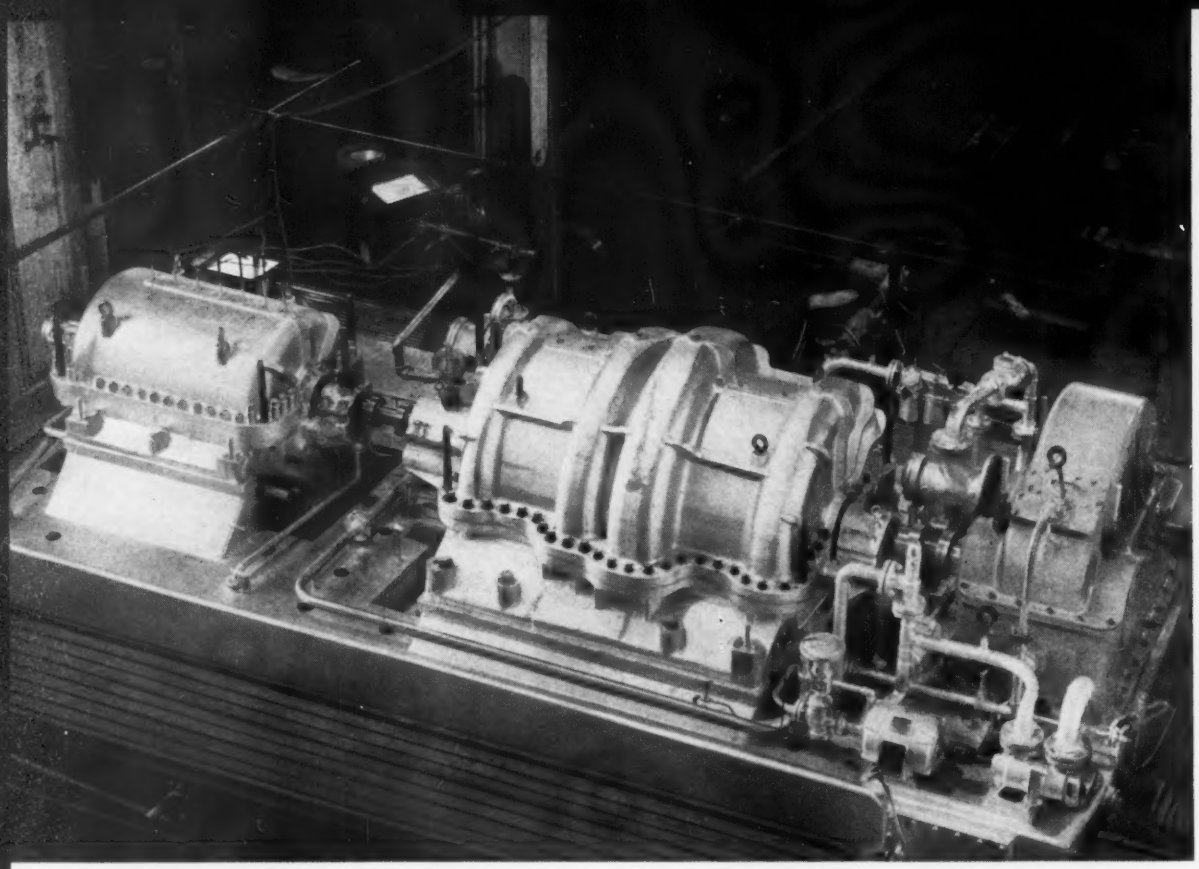
By present method of calculation:

Momentary = 20 x 1.6 = 32

Calculate interrupting:

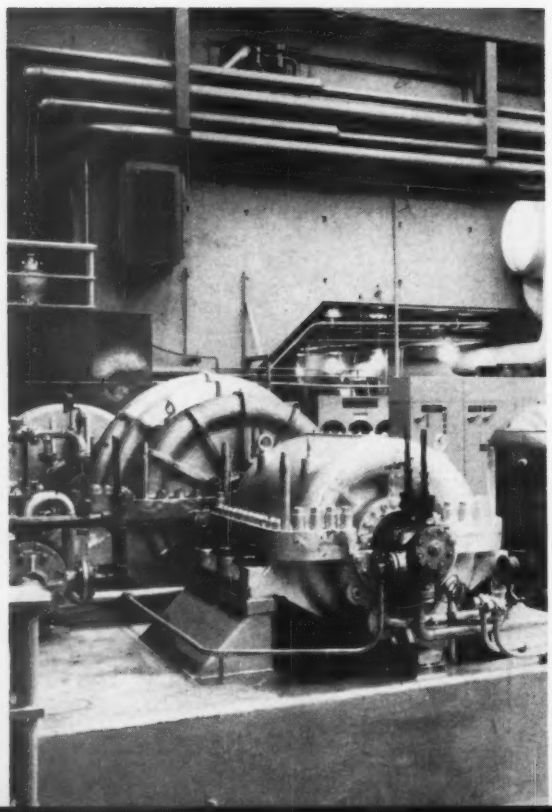
4-c cp	17.3 x 1.0 = 17.3	$\frac{32/17.3}{1.6}$	= 1.15, therefore 20
3-c cp	17.3 x 1.1 = 19.0	$\frac{32/19.0}{1.6}$	1.05, therefore 20
2-c cp	17.3 x 1.2 = 20.8	$\frac{32/20.8}{1.6}$	= 0.97, therefore 20.8

* Breaker rating



CENTRIFUGAL COMPRESSOR for central-station service is on shop test. Speed increaser, right, raises motor to compressor operating speed. First casing, center, takes atmospheric air and discharges through intercoolers to standard multistage machine, left

Centrifugal air compressors fill needs

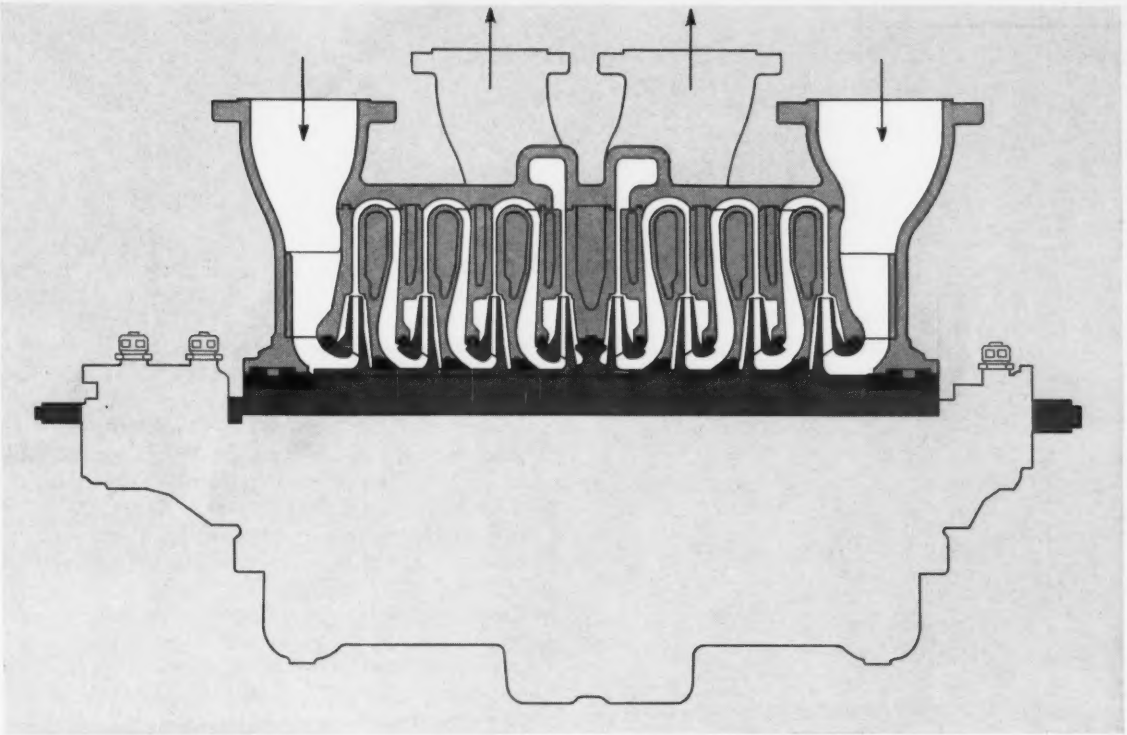


Growth in central-station air needs combined with lower minimum capacities for centrifugal compressors increases application potential

By MARTIN RAGSDALE, De Laval Steam Turbine Co

Compressed air at various pressures is used throughout modern steam-power plants for general services, instrument and control air and frequently soot blowing. For this reason large air compressors are always included in a central-station design. In the past, these have usually been rotary or reciprocating types. Only recently have

CENTRAL-STATION INSTALLATION of a centrifugal compressor serves soot blowers, provides station service and instrument air



CENTRIFUGAL-COMPRESSOR SECTION shows double casing and impellers arranged in two groups back-to-back. This produces axial balance and relieves thrust-bearing loading. For air service some shaft leakage can be tolerated, simplifying shaft-seal design

# of large central generating stations

centrifugal compressors started to become a real factor.

Centrifugal compressors are not new, so why haven't they been used before? Historically, they have been associated with high-volume low-pressure-ratio applications. Minimum allowable capacities for single machines have been larger than central-station air needs at normal soot-blowing pressures. And the centrifugal compressor is basically a continuous-duty machine while usual soot-blowing and other air requirements have been intermittent. Finally, centrifugal compressors have been relatively inefficient when compared to reciprocating machines of the same rating.

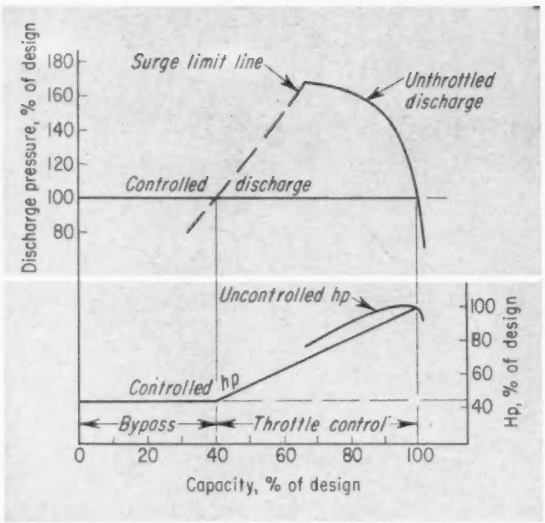
Recent trends in *both* central-station and centrifugal-compressor design have brought needs and capabilities closer together. Steam boilers are getting larger year by year. The largest now have so many sequenced blowers that soot blowing is almost a continuous process. With proper selection, a centrifugal compressor to furnish soot-blowing air can be designed for continuous operation.

Air requirements in some cases exceed yesterday's minimum capacity limits, and centrifugal-compressor design advances have reduced minimum allowable capacities. The old gap has closed, and for pressures needed by modern soot-blowing equipment, 250 to 300 psig, centrifugal compressors are now available to provide adequate service at capacities as low as 5000 scfm.

Let's take a look at advantages of centrifugal compressors, now that their application in central stations is feasible. High availability and resultant low maintenance costs top any compressor type. Rotary motion as opposed to reciprocation minimizes vibration problems and foundation mass needed. Floor-space requirements are lower than for reciprocating compressors of the same rating. Centrifugal compressors deliver oil-free air—avoiding an explosion hazard in air-piping systems and eliminating severe maintenance problems in instrument-air equipment. Control of unattended centrifugal compressors fits in well with modern power-plant automatic-control concepts.

Typical multistage centrifugal compressors are made up of a forged-alloy-steel shaft mounting multiple impellers and rotating in a horizontally split casing. Casings are high-tensile cast iron or steel. Impellers are low-alloy forged steel welded or riveted together. Compression is achieved in successive steps of adding velocity (kenetic energy) to the air at each impeller and converting this energy to pressure (potential energy) in interstage volutes or diffusers. Overall compression ratio is varied by changing the number of stages. Compressors, driving gears and lube auxiliaries are mounted on a single fabricated-steel bedplate. Intercoolers and moisture separators can be separately mounted below the operating floor or can form an integral part of the machine's supporting structure.

continued



PERFORMANCE CURVE for centrifugal compressor shows throttle control down to about 40% of rating, then bypass control to zero

Pressures needed in most central-station applications, 250 to 300 psig, require two separate multistage machines in series driven in tandem by an electric motor through speed-increasing gears. Where high-speed turbines are used, drive can be direct, of course.

A typical centrifugal compressor of the type now in operation is shown on first page. To give the needed 250- to 300-psig discharge pressure, 11 to 15 stages of compression would probably be required and likely would be equally divided between the two casings. Air is withdrawn after passing through half the stages in the first casing, cooled in an external tubular heat exchanger and returned for further compression in the remaining first-casing stages. These two half-sections of the first casing are opposed to balance axial thrust—that is, their impellers face in opposite directions, see sectional drawing. Air discharged from the first casing is again cooled externally and then delivered to the second casing—a conventional multistage compressor. Intercoolers are usually designed for 85-F inlet water with a 10-F rise.

Centrifugal-compressor designs for central-station application are not static. As a matter of fact, equipment being offered today for central stations differs in arrangement from most machines now in use. While two machines or casings in tandem are still in the picture, the first, low-pressure casing will probably have three stages of intercooling. In fact, all these coolers could be integral with the compressor base. The first machine then is a standard 100-psi design and the additional intercooling increases its efficiency considerably.

An external tubular heat exchanger is used between the two casings in an arrangement similar to the older one. Then a conventional multistage compressor raises air pressure to the required 250 to 300 psig with no intercooling. Air for soot blowing is used as discharged while plant air goes through an aftercooler before entering the distribution system.

Automatic control systems maintain constant discharge pressure with varying demand by suction throttling down to about 40% of design flow. They provide for complete unloading without stopping the compressor by opening a discharge bypass to suction or atmosphere. Control system senses pressure of downstream air. As demand declines, it closes the suction butterfly valve to reduce discharge flow. If need arises, capacity is further reduced by opening the discharge bypass, but hp is not further reduced. It stays at about 48% of full-load hp for all capacities less than 40% of design flow.

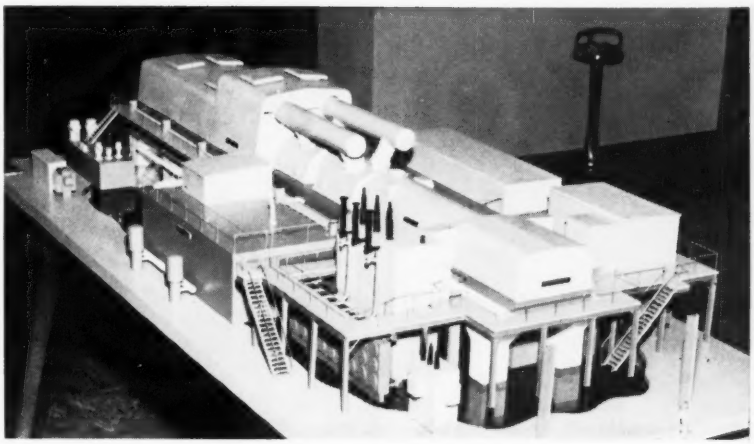
As a minimum, air should be cooled to about 100 F in the intercoolers to keep discharge temperature within limits of mechanical design and to reduce hp needs. This also boosts efficiencies, which can now make a very fair approach to those of a reciprocating machine.

Typical centrifugal compressor is now serving a 2-million-lb-per-hr boiler. This requires a compressor inlet capacity of 7000 scfm; discharge pressure is 300 to 350 psig. Compressor is driven by a 3000-hp 4-pole motor through speed-increasing gears. Compressor runs at 8500 rpm. It provides soot-blowing air at full discharge pressure, and instrument, control and plant-service air for pneumatic tools and hoists can be taken from an intermediate stage at 100 psig. Alternately, service air can be reduced from full discharge pressure. Seal air for pressurized furnaces is also provided by this one machine.

Start-stop controls and pressure-temperature indicators are in the main station control room; no operator attendance is required at the compressor location. All important operating data—bearing temperatures, air flows and pressures—are monitored.

Currently the minimum generator size that can justify a centrifugal compressor is about 200 to 225 mw. But their continuing development will soon permit application well below this minimum generator size. Smaller units would need oversized compressors continuously operating in the throttled or bypass range. Larger units of 500 mw and up are unquestionably suitable for centrifugal compressors. And centrifugal-compressor efficiencies are on the increase through improved components as well as additional stages of intercooling. Centrifugal compressors will become a more-familiar sight in the large central power stations of the future, providing all station air-service needs.

By J B THOMAS
President and General Manager
Texas Electric Service Company



MODEL shows turbine assembly of Texas Electric Service Co's 350-mw Handley addition

The turnkey contract– a new approach to steam-power-plant construction

Texas Electric Service, a unit of the Texas Utilities System, has recently let a new kind of contract for construction of a large central steam-electric generating station. Complete contract for the 350-mw addition to their Handley Station has been awarded to the Westinghouse Electric Corporation. This "turnkey" setup places sole responsibility for the plant addition—including foundations, piping and all equipment—on one prime contractor.

Basic objective here was to take advantage of the increased size and strength of our large manufacturers to make more compact and less expensive the installation of a turbine-generator and its accompanying equipment. It was also felt this approach would aid U.S. manufacturers in competing overseas.

An attractive operating arrangement was developed for conservative tandem-compound high-pressure subcritical units rated 300 mw or more. Throttle conditions are 2400 psig, 1000/1000 F; speed: 3600 rpm.

This design came about through combined efforts of the operating company, their consultants, three manufacturers equipped to build these large turbine-generators and the consultants engaged by each manufacturer. The very high degree of cooperation achieved by all these groups was a prime factor in the project's success.

Basic approach: First, challenging every important element of plant design as to its cost, operating characteristics, actual necessity and possible improvement. Second, the firm belief that the best way to meet operating-company problems is to bring every element possible into shape for repetitive manufacture under a plan of unified responsibility.

Completed cost of the Handley unit as an addition to—but essentially separate from—an existing plant is less than $80 per kw of rated capacity. In addition to the benefits of unified responsibility, cost savings were made possible by these design points:

(1) Outdoor construction as previously proved successful for our area of the country.

(2) A low-set twin-side-outlet-condenser arrangement with a gantry crane.

(3) Extraction heaters placed on or directly attached to the condenser and low-pressure-turbine assembly.

(4) Full-capacity main boiler-feed pump driven through a hydraulic coupling from a turbine-shaft extension. (A 30%-capacity motor-driven startup and emergency boiler-feed pump is provided.)

(5) Greatly simplified piping and valving.

(6) Main leads from side of generator connecting directly to adjacent stepup transformer.

(7) Electrical controls located at or on generator-support structure.

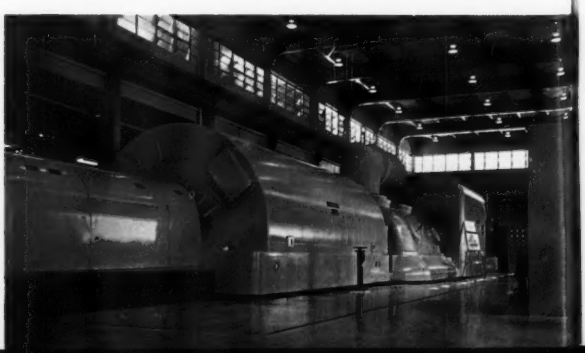
(8) Boiler located nearby, with water-handling and fuel-burning equipment as a unit.

(9) Control room and data-logging equipment placed immediately at the turbine-support structure.

(10) Substantial regrouping of turbine and auxiliary units so more of the turbine-generator can be assembled at the factory and unit can be fitted for much easier and quicker field assembly.

We believe, whether an operating utility relies on its own engineering staff for plant design or on the services of a consulting engineer, substantial saving can be had by essentially repetitive design of the turbine auxiliary assembly. Our industry has great opportunity for progress —through applied research directed toward the needs of the operating organization.

A careful survey of your plant by a qualified consulting engineer could show ways of making substantial savings in power costs.



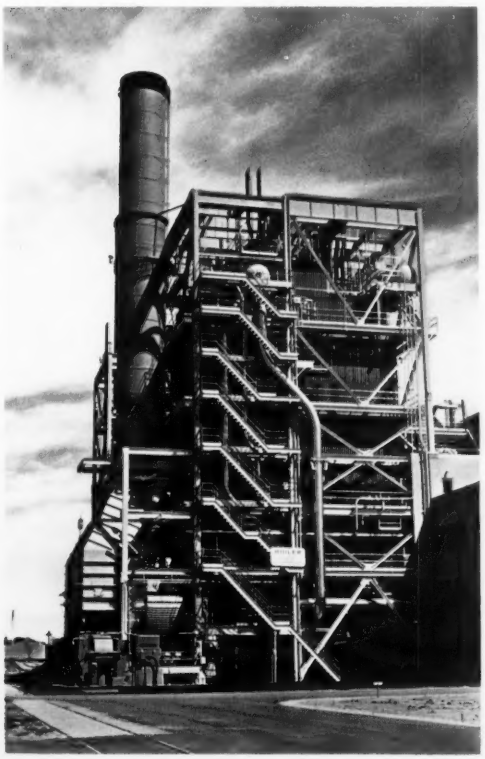
Another RILEY Boiler in Texas Helps to Boost Productivity in the Lower Rio Grande Valley

No. 2 Boiler
J. L. Bates Power Station
Central Power and Light Company

Engineering Data

Steam Capacity — 750,000 lbs/hr
for 4 hours — 800,000 lbs/hr
Design Pressure — 1750 psig
Superheat — Reheat 1005/1005F
Steam Temp. Control — Spray, Dampers
Fuel — Gas and Oil
Pressurized Setting
Efficiency — 88.10%

Sargent & Lundy
Consulting Engineers



During 1960 Central Power and Light Company, Corpus Christi based Texas utility, completed an extensive expansion program to its system with the installation of the No. 2 unit at J. L. Bates Power Station near Mission, Texas in the Rio Grande Valley. This unit adds 110,000 kilowatts to the system capability, bringing it to 953,000 kw — five times the capability of 10 years ago.

The Riley Reheat Boiler was selected as a result of a program designed to lower the cost of kilowatt production and to offset the increase in the cost of fuels.

Central Power and Light Company is one of several Texas utilities using Riley boilers. A total of over 16 million pounds of Riley steam has been purchased by utilities for Texas central stations since 1950, indicating the industry's remarkable growth, and increasing acceptance of Riley steam generating and fuel burning equipment.

RILEY UTILITY BOILERS IN TEXAS **(Installed and on order)**

HOUSTON LIGHTING & POWER CO.	11 Units —	6,440,000 lbs/hr
TEXAS ELECTRIC SERVICE CO.	4 Units —	5,861,000 lbs/hr
DALLAS POWER & LIGHT CO. .	3 Units —	3,450,000 lbs/hr
CENTRAL POWER & LIGHT CO.	1 Unit —	725,000 lbs/hr
SOUTHWESTERN POWER CO. .	1 Unit —	650,000 lbs/hr
SOUTHWESTERN PUBLIC SERVICE	1 Unit —	330,000 lbs/hr

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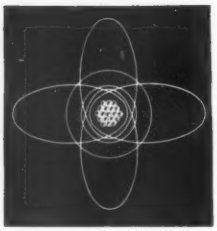


Nuclear notes

By B G A SKROTZKI, Associate Editor

New Russian plant, the Novovoronezh Atomic Power Station, is under construction. First section, with three 70-mw steam turbines supplied by one pressurized-water reactor, will start operating in 1962. Fuel will be about 44 tons of enriched uranium with a life expectancy around 18 months. Reactor vessel is reported as about 36-ft high, 12-ft dia. The light-water-moderated reactor will be pressurized to about 1470 psi and produce turbine steam in the neighborhood of 515 F. (*McGraw-Hill World News*)

India may ask Soviet help to set up its first nuclear-power plant. This would avoid accepting the International Atomic Agency's system of inspection and safeguards which India says infringes on its national sovereignty. Draft of the Indo-Soviet agreement for cooperation in atomic energy is ready and will be signed in the next few months. The Soviet would help India set up power stations and explore for atomic minerals. India claims it can make an atomic bomb within two years if it so desires. (*McGraw-Hill World News*)

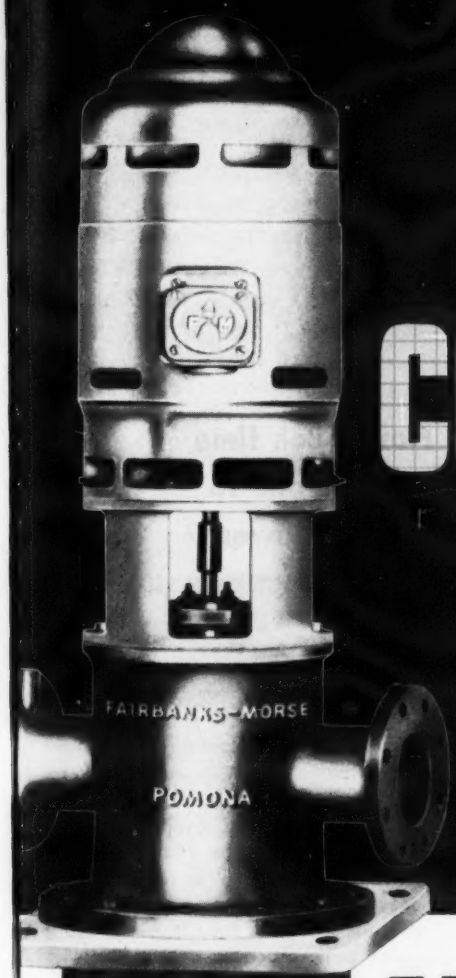
Japanese AEC has adopted a long-term program calling for 1000 mw of atomic-power-plant capacity by 1970, 7000 to 9500 mw by 1980. The first plant would be a gas-cooled Calder Hall type; the second, light-water-cooled reactor with enriched-uranium fuel; the third and others would be either light-water or gas cooled. Radioisotopes for industry, agriculture and medicine will be promoted. The first Japanese nuclear-propulsion ship will be built in 1968-'70. The government will budget $500 to $555 million during the next 10 years for the program and double their number of atomic-energy scientists and engineers—to around 13,000. (*McGraw-Hill World News*)

Organic-cooled and -moderated reactor of 50-mwe capacity to be included in the AEC nuclear-power-demonstration projects has received expressions of interest from: (1) Burlington, Vt. (2) Greenville, Texas (3) Hamilton, Ohio (4) Choptank Elec Co-op, Inc, Denton, Md. (5) Dairyland Power Co-op, La Crosse, Wis. (6) Delta Electric Power Assn, Greenwood, Miss. and Southwest Miss. Elec Power Assn, Lorman, Miss. (7) Grand River Dam Authority, Vinita, Okla (8) Mineral County Power System, Hawthorne, Nev. (9) Plains Elec Generation and Transmission Co-op, Inc, Albuquerque, N.M.

"Costs of Nuclear Power," a 40-p pamphlet, can be bought from the Office of Technical Services, U.S. Dept of Commerce, Washington25, D.C. for 50¢ a copy. This revised report gives data on several new reactor plants, costs of several U.S. and foreign plants and discusses research and development costs, construction costs, working capital, annual fixed charges, fuel-cycle and operation and maintenance costs. An interesting comparison in the report as of 1960:

Power-plant type	*Nuclear fired*	*Fossil-fuel fired*
Construction cost per net kwe	$300-$400	$150-$200
Plant factor, %	80-70	80-70
Generating cost, mills per kwhr		
Fixed charges on construction	6.5-10.0	3.0-4.5
Fuel costs	3.5-5.5	2.0-4.0
Operation and maintenance	1.0-2.0	0.5-1.0
Total generating costs	11.0-17.5	5.5-9.5

Reactor materials mostly affect the cost of nuclear power, says U M Staeble of AEC. Effective R&D on materials depends on pinpointing effort rather than trying everything.



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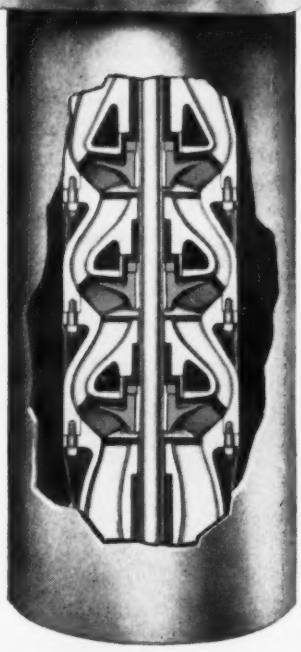

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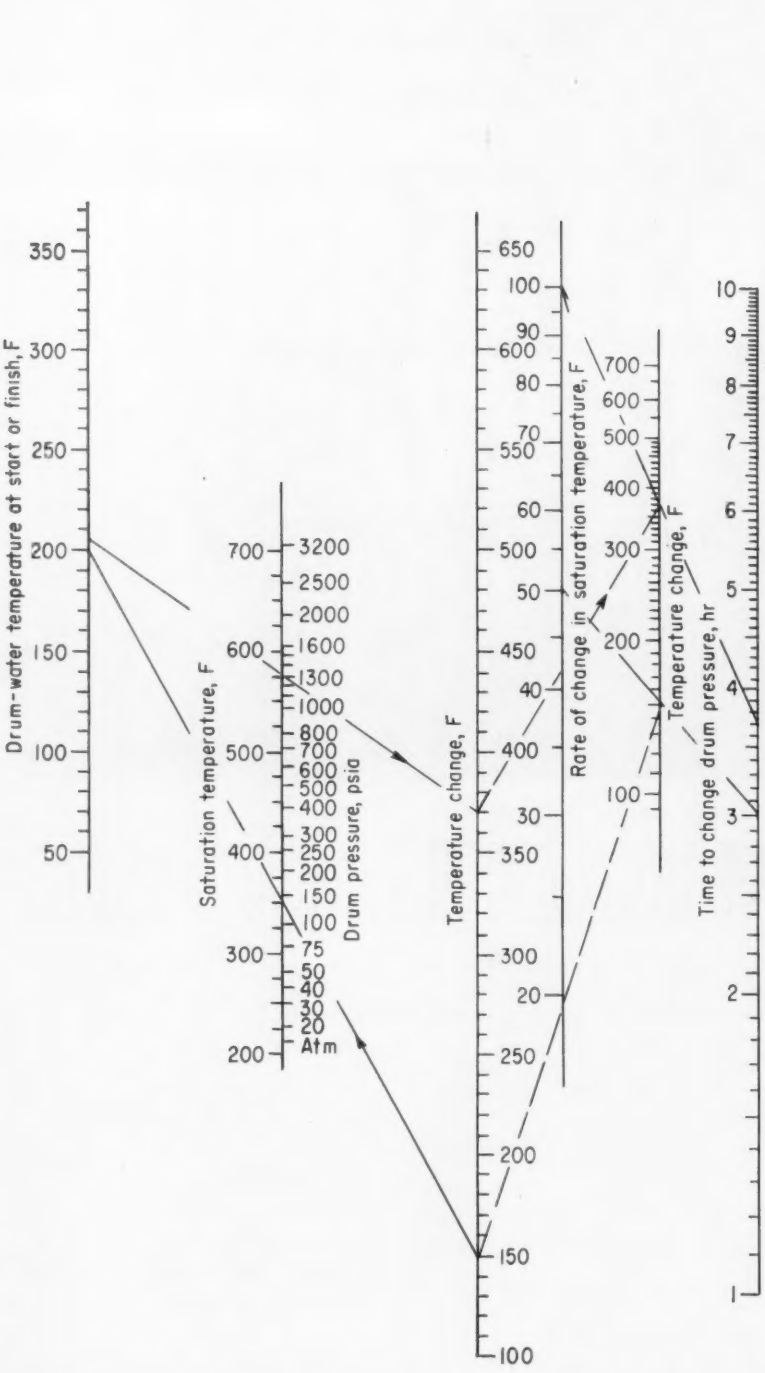
Power's data sheet

No. 344



How much time does it take to raise or lower boiler-drum pressure?

Preplotting curves for raising or lowering drum pressure permits careful control of temperature differentials. Nomograph may be used to plot rise or fall of pressure on recorder charts for operating guides. Once you've determined rate you can cut a cam to act as template for future chart guides, or for automatic control.

Example: What time is required to cool boiler to atmospheric pressure, given operating pressure of 1300 psia, 100-lb-per-hr cooling rate?

Solution: Connect drum-water temperature at finish—212 F—with 1300 psia; read change—370 F. From rate scale—100 F—draw line through temperature change of 370 F to time scale. Read 3.65 hr.

Reverse procedure determines pressure at end of 3 hr for 50-F-per-hr drop from initial temperature of 200 F. Read answer on drum-pressure scale—135 psia.

M L Myers, *Concord, Tenn.*

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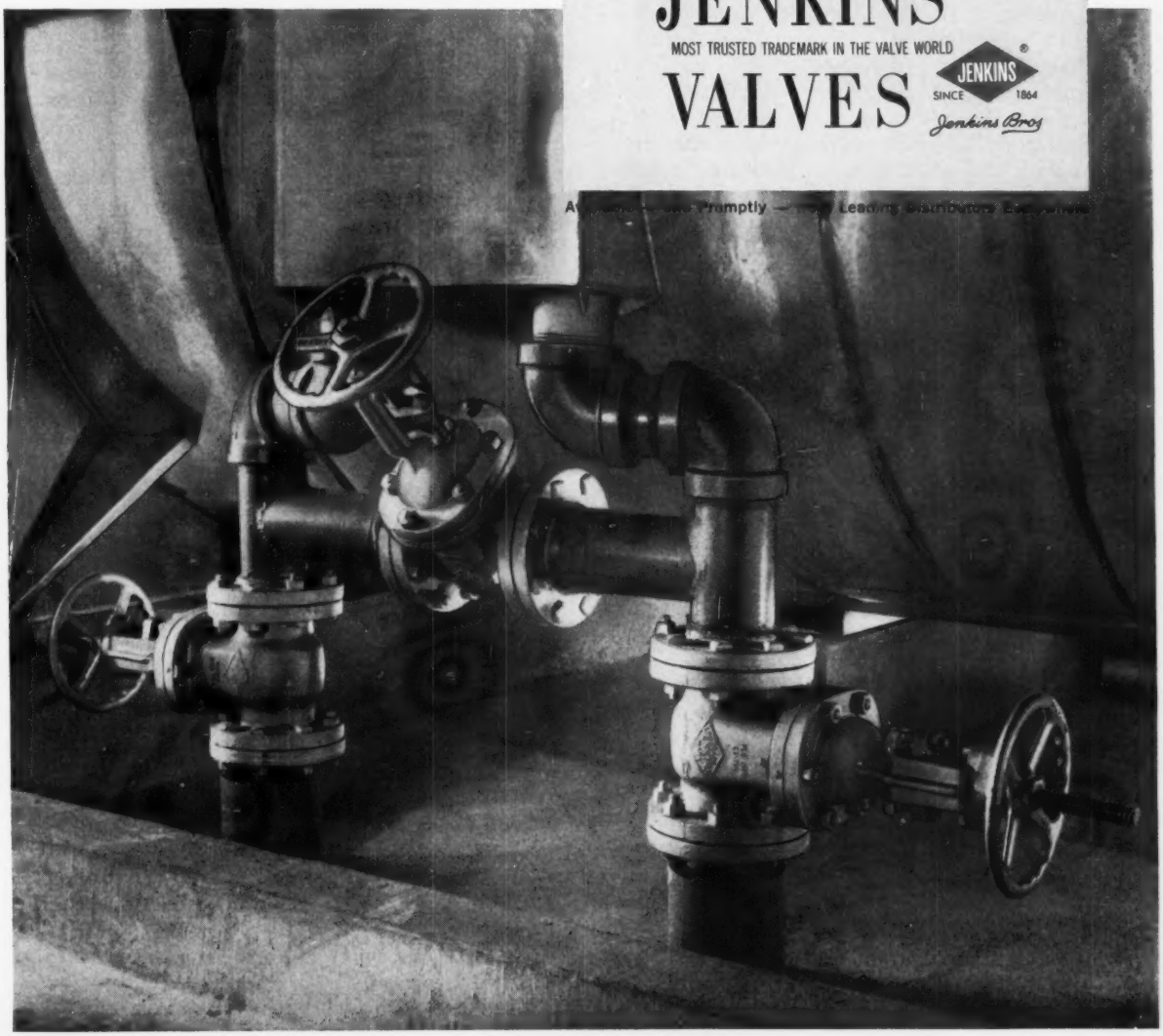

For more facts circle 249 on Reader Service card, p 103

Technical briefs . . . A world-wide look at

Communist China's power-generation capability surges forward

Introduction to engineering in Communist China, *T C Tsao, Columbia University*
History of engineering and industrial efforts in Communist China is traced from the close of the Korean War to date. In 1953, first 5-yr plan ('53 to '57) was initiated. Industrial expansion fell short of goals but construction relating to defense was pushed.

In 1956, National Industrial Construction Conference set aims of speed, quality, economy. Also in '56, a 12-yr plan was adopted. Goals: learn the advanced industrial experience of the Soviet Union, quickly acquire fruits of international and other large-scale scientific research and development. National target at that time was to catch up with Great Britain in the output of major industrial products in less than ten years.

Second 5-yr plan ('58 to '62) set up a so-called "big leap forward" program. In many areas, goals set appear achievable. Examples: 12-million-tons steel production was programed for 1962 — in 1959, 13.35 had been achieved. 43-billion kwhr were set for 1962—by 1959, 41.5 had already been attained.

Engineering in China today bends every effort to fully utilize technical assistance from the Soviet Union and—to a much lesser degree—from East Germany and Czechoslovakia. Technical aid breaks into three classifications: technical experts, equipment and publications. *AAAS*

Mechanical engineering in Communist China, *E K Nieh, Ebasco Services, Inc*
Current Chinese People's Republic reconstruction program sets annual power-generation increase at 20%; 5% of this is hydro. This means an annual construction of 700 to 900 mw. Compare this with current U.S.S.R. program of 5000- to 6000-mw annual increase (in the U.S., present annual growth rate is about 10,000 mw).

Production of power-generating equipment in China: 198 mw in 1957, 800 mw in 1958. By August 1959, 1150 mw had been produced—about 64% of the 1959 predicted total of 1800 mw. By 1958, 25-mw turbine-generator units were in regular production. Work was started in 1958 on 50-mw units to operate at 1280 psig, 932 F and 3000 rpm. But present state of turbine-generator manufacture in China is based on a very short history. First unit was built in '53, a 6000-kw machine. Manufacture took two years. Current 50-mw machine took six months to build.

During this same period hydro units of 72,500 kw were developed and production rate has exceeded expectations. This has hastened the completion of the Hsin-an Chaing Station.

Many steam generators in the 88,000- to 286,000-lb-per-hr range have been built in China in recent years. Current development work involves a 506,-000-lb-per-hr unit designed for 1420 psig. Standard boiler designs are suggested in six sizes up to 900,000 lb per hr at 2000 psig and 1050 F. Although pulverized-coal firing has been used, combination spreader and chain-grate stokers appear most popular at this time. They feel that at pressures above 2550 psig, once-through steam generators can cut costs by 40% and reduce material requirements by 20%.

In addition to electric generation, report covers the machine-tool industry in China today and compares 1952 to '59 production of such items as electric motors, transformers, metal-cutting machines, plows, railroad equipment, ships, trucks and bicycles. *AAAS*

Electrical engineering in Communist China, *T C Tsao, Columbia University*
Long-range power development in Communist China is based on development of hydro resources. In 1944 the U.S. Bureau of Reclamation, together with Chinese engineers, surveyed the Yangtze River basin and determined an ultimate capability of some 220-million kw. And the Hwan-Ho River has an additional 23-million-kw capability. In this long-range development program installed capacity per power station will be 15,000 to 20,000 mw in unit sizes from 450 to 1000 mw.

Present power-distribution systems in the Chinese People's Republic are generally 220 kv with some regions having 154- or 110-kv nets. But with ultimate long-range development nets covering a radius of 600 to 750 miles, 330- and 600-kv ac as well as dc distribution systems are under study.

Short-range power development has concentrated on thermal plants augmented by some easily developed hydro. During the period 1952 to '57, 91 power plants were built of which 75 were thermal and 16 hydro. Capability of these 91 plants was 2,050,000 kw.

Second 5-yr plan ('58 to '62) emphasizes hydro power. Experience has shown that Chinese hydro plants cost only 40% more than an equivalent

Directions for ordering these papers on page 98

thermal plant. During 1960, 4.2-million kw were installed bringing total capacity up to about 58-million kw. Currently China is operating four nuclear-power reactors built with assistance from the Soviet Union.

Reports indicate that thermal plants go up fast in Red China—Ming-hong station was built in 39 days from ground breaking to generator loading; Chapei, 85 days (sizes of these thermal units is not determined).

Per-capita power consumption in CPR is only 90 kwhr vs 4250 kwhr in U.S. and 2120 kwhr in England.

Report also covers rural electrification, railroads and telephone, radio and television communication status in CPR. *AAAS*

Control-room design

Present design practice of centralized control rooms in Pacific Gas and Electric Company's power plants, *Einar Nilsson and G A Abbott, Pacific Gas and Electric Company*

Central control rooms in PG&E plants date from the early 1940's. Latest unit control-room sizes have been cut, from 5600 to less than 2000 sq ft.

At their new Pittsburgh plant one control room serves four 165-mw units. This, they feel, is a maximum. Latest improvements in central-control-room design have produced a 50% reduction in total plant panel-instrument space needs, inside and outside the control room. At the same time, number of instruments available to control room operators has gained significantly. Present panel space needed for a 330-mw unit is 80% of that previously required for two 165-mw machines.

Control-room development has helped PG&E cut manpower needs from one man per 1700 kw to one per 5200 kw. This includes total plant force—clerks and supervisory personnel as well as operators and maintenance men.

Plant communication and annunciator systems were given special attention at PG&E. In all cases where normal communication channels use loudspeakers or portable radios, a direct-wire telephone channel is provided as a backup.

Luminous ceilings have proved best—furnishing 30 to 40 ft-candles on vertical control-room surfaces. But careful design is a must to preclude the rapid dirt accumulation that eats into effectiveness.

Control-room design reflects philosophy that best fire protection is fire prevention. Construction materials used will not support combustion, and grating-covered trenches at each control-room door prevent inflow of combustibles from broken lines. Double wire-glass windows and Class B 1½-hr rated doors complete the picture. *AIEE CP 61-216*

A central control room for Dickerson units 1 and 2, *C W Schmitz and C S Bilisoly, Potomac Electric Power Company*

Potomac Electric's latest units, two 175-mw machines at Dickerson, are controlled from a central room. Previous practice called for three control locations—boiler, auxiliary and electrical.

Under new central-control-room setup, Dickerson's manpower needs have dropped to five men per shift: one watch engineer, two control-room operators (one a working supervisor) and two roving operators.

But all station control is not centralized in this one location. Examples: control functions requiring manual operation for safety and those not needing constant operational supervision—bunker filling, water treatment and warmup ignition torches.

Plan and elevation sketches completely describe central-control-room layout. Control, cable-tray and telephone rooms are air-conditioned by a heat pump on the roof. Arrangement lets them use 100% outside air if refrigeration system fails.

Lighting received special attention. Center desk gets 140 ft-candles; benchboards get 100 to 120 ft-candles; vertical boards, 55 to 80 ft-candles. *AIEE CP 61-215*

Electrical equipment

The effect of temperature, humidity and current on collector ring and brush wear, *D J Herder and W Kerber, General Electric Company*

A total of 17 500-hr tests were run under varying humidity, temperature and current conditions on carbon brushes to determine wear characteristics. Results: for operation of grooved collector rings in uncontaminated air, natural-graphite brushes containing no polishing agent gave significantly less wear on the positive ring than did natural graphite brushes containing the polishing agent. Generally, decreased ring and brush wear can be had with a given brush grade by reducing ring temperature, increasing humidity and decreasing current—these variables are listed in order of importance.

Tests brought to light some additional generalizations: (1) At low absolute humidities, changing from grade-A to grade-B brushes will increase brush wear, total loss and ring temperature. Increased humidity tends to reverse these trends. (2) For grade-A brushes, friction loss is primarily a function of current and increases with it. For grade-B brushes, friction loss depends on humidity—decreasing with increasing humidity. *AIEE CP 61-143*

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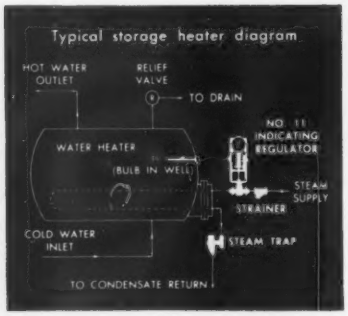

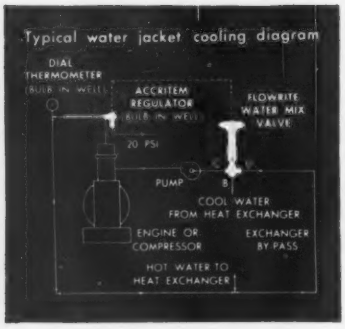

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Technical briefs

Begins on page 92

Standards

Proposed standard for molded-case air circuit breakers. *AIEE working group*
This standard covers molded-case single-pole or multipole air circuit breakers assembled as a complete unit and cased in a supporting or enclosing housing. Current ratings up through 800 amp are included in frame sizes not exceeding the rating; voltage ratings are covered through 600-v ac and 250-v dc, interrupting ratings of more than 10,000 amp.

Individual sections in the proposed standard: service conditions, definitions, ratings, temperature rise, insulation and dielectric requirements and nameplate markings. Also included: rating standards and test procedures, an application guide for these breakers. *AIEE CP 61-205*

Interrupting ratings for low-voltage circuit breakers on a symmetrical basis, *NEMA joint sections committee*
These new interrupting ratings for low-voltage circuit breakers—600 v—are based on symmetrical currents while the old standards were on an asymmetrical-current basis. Application under the new standard will generally select the same or occasionally a smaller breaker for the same current. Only the approach to the problem has changed—result: simplified application.

Discussion covers use of symmetrical ratings and includes several illustrative examples. *AIEE CP 61-130*

Other energy systems

Condensing water—how does it affect the river? *M D Engle, Pennsylvania Power and Light Co*
Thermal loading of natural waterways by steam-power-plant discharge is receiving great attention by many segments of society—technical, political and sporting. Many supported and unsupported claims cloud the issue.

continued

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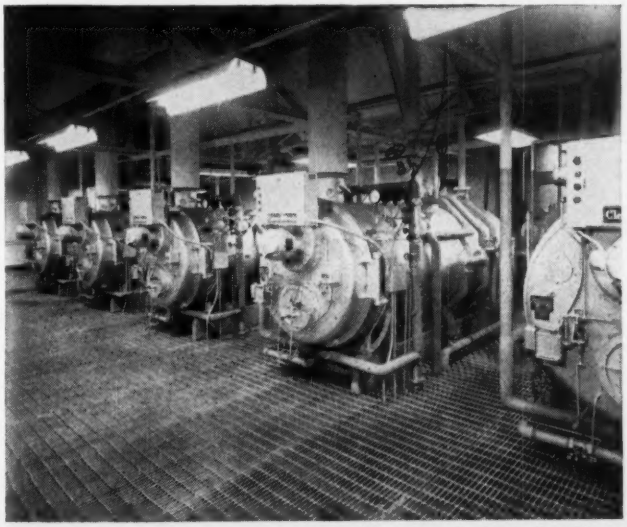
Diebold, Inc., Canton, Ohio, century-old manufacturer of bank protection and office equipment, replaced old, coal-fired boilers with new, fully automatic, gas-fired CB boilers and saved $15,000 to $18,000 in annual manpower cost. *All five of these new boilers are operated by just one man* — other personnel have been transferred to more productive work assignments. Bill Roby, assistant plant engineer, speaks highly of the ease of installation and the compact design.



New or old, there's one thing about any boiler that's up-to-date: you have to pay today's wages for the men who tend it. This becomes out-of-line overhead if you're operating a boiler designed in the days when man-hours were far less costly.

As wages have doubled during the past two decades, one manufacturer, Cleaver-Brooks, has pioneered in making a boiler that requires fewer man-hours to operate. Today's CB packaged boilers provide a combination of labor-saving design features and performance standards that cannot be found in any other boiler — at any price.

Hinged doors, front and rear, provide for quick cleaning of the tubes. It takes only 40 seconds to remove and replace the retractable burner nozzle. Fully automatic, these boilers include electronic safety devices which release the operator for other duties. And, because some jobs require quick changeover from one fuel to another, Cleaver-Brooks boilers are designed to make this change in less than a minute.

All this is provided by Cleaver-Brooks in the most compact, fuel-saving packaged unit on the market. Sizes through 600 hp . . oil, gas and combination oil-gas firing . . . larger sizes in Cleaver-Brooks Springfield water-tube boilers. All models completely pre-engineered and tested as a package . . . expertly started for you by a trained field engineer.

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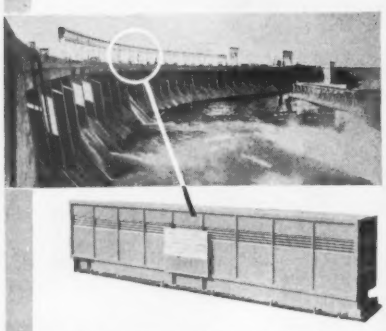

For the second largest hydroelectric power plant in the United States at Massena, New York—as part of the St. Lawrence power project—Uhl, Hall & Rich, project engineers, selected MURCO Gate Hoists to control the water level at Long Sault Dam. Each hoist weighs 93,000 lbs. . . . overall length 57 feet, 8½ feet wide, 12½ feet high . . . lifting capacity of 175 tons and will raise and lower the gates in a dam at a speed of 1 foot per minute.

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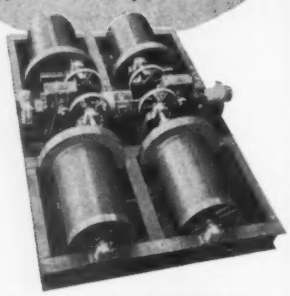

One of the two 380-ton MURCO Gate Hoists furnished to the Power Authority of the State of New York.

Each hoist operates a gate 46' wide by 67' high at one foot per minute. These gates divert the water from the Niagara River above the Falls into covered conduits five miles long. The two conduits bring the water to the Niagara Generating Plant on the United States side of the Falls.

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Technical briefs

Begins on page 92

Lehigh University's Institute of Research ran some tests along the Delaware River downstream from PP&L's Martins Creek Plant. They brought to light many interesting facts, nailed down some firm data and lifted the cloud a bit. Test site was ideal since the Delaware here is free of industrial contaminants.

Temperature traverses showed that 4500-ft downstream, surface-water temperatures had returned to normal. Station discharge lies on the river surface, extending not more than 2½-ft down. So 85% of river flow is unaffected.

Effect on plant life was noticeable only 1500-ft downstream from station discharge and on the near shore only. No effect could be found elsewhere along river banks.

During cold weather the best fishing in the river is just below station discharge. But during summer months, fish tend to avoid a triangular area starting at point of discharge. They are found in cooler waters outside this triangle. Tests showed no indication of a fish-kill produced by the power plant. *ASME 60-WA-92*

Natural gas—the pipeline industry, *B D Goodrich, Texas Eastern Transmission Corp*

Starting slowly in the 1920's, growth of the natural-gas industry has gained tremendously since World War II. It now accounts for 26.5% of the nation's total energy requirement.

This growth period has seen many technological changes in the gas-transmission industry: increased use of centrifugal pipeline compressors, larger and higher-stressed pipelines, higher operating pressures and a wider choice of prime movers—the gas turbine, for example.

Future of the industry holds many challenges. Prime base-load customers were gleaned long ago, so now high-demand low-load-factor service is the development area. Competition with other energy sources will become more severe, but natural gas's

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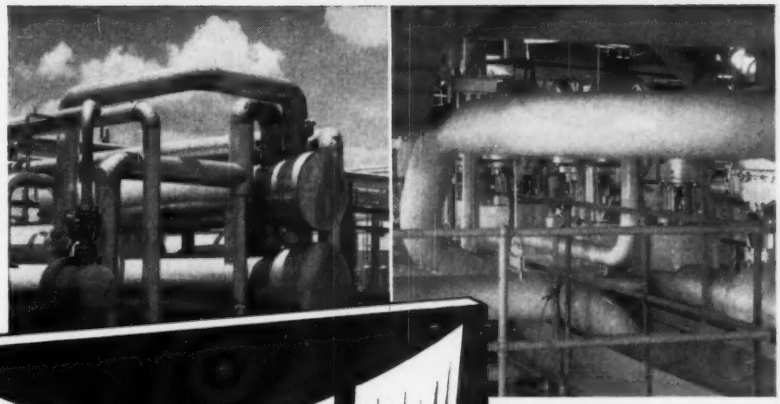

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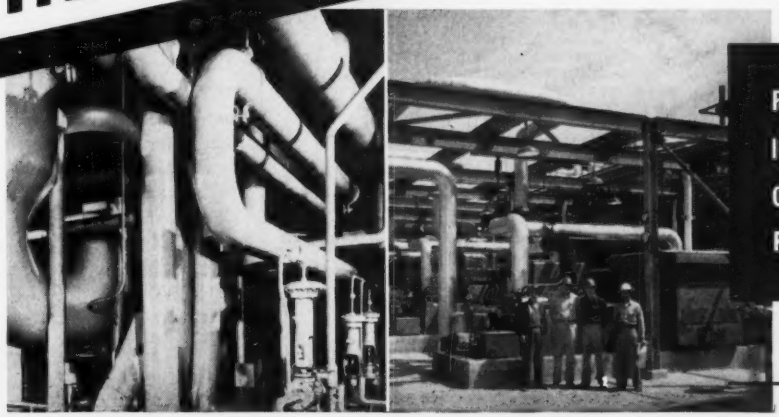

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Adjustable SPROCKET RIM
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Changes that Danger Zone to a
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—saves you money
ON EVERY VALVE

Every minute saved is money in your pocket. Cut out the waste of time, labor, floor space due to hard-to-reach valves. At the same time, convert Danger Zones to Safety Zones. Equip every overhead valve in your plant with Babbitt Adjustable Sprocket Rims with Chain Guides for day to day economy.

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- They operate any valve from the floor.
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- A hot-galvanized rust proof chain is available for all sizes.

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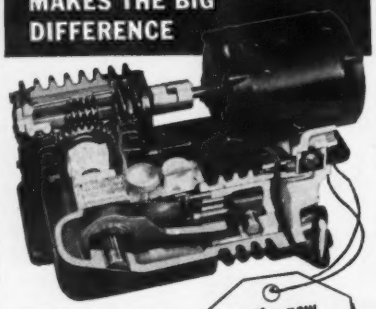
UNITIZED CONSTRUCTION
MAKES THE BIG DIFFERENCE



in the new MADDEN *Metriflow* METERING PUMP

Unitized construction means it's completely enclosed, locked in permanent alignment, sealed against leakage, dirt and weather. All moving parts inside run in oil. Heavy duty design includes machine cut gears, outboard bearings on pump drive shaft. Solution heads of special materials available for slurries, corrosive liquids. Four standard sizes, up to 54 GPH, pressures to 300 psi. Duplex units provide twice the capacity with one motor.

Write for complete information on the new Madden METRIFLOW Metering Pump

MADDEN The MADDEN CORPORATION
1345 Jarvis Ave. Chicago 26, Ill.

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Technical briefs

Begins on page 92

share of total energy needs should rise from the present 26.5% to 30% in ten years. *ASME 60-WA-43*

Performance of stainless-steel condenser tubes, *R H Pell, Monongahela Power Company*
Monongahela Power's Rivesville Station cooling water can go as low as 3 pH in the dry season. Cause: upstream coal-mine drainage. So corrosion and fouling have shortened brass (88-10-2) condenser-tube life. Tube life under seven years has been common.

In 1958, studies of AISI type 304 indicated longer tube life and better operation because of cleaner, thinner-walled tubing—Bwg 22 vs 16. Operation of an AISI-304-tubed condenser since then has been even better than expected. Cleaner tubes have cut calculated heat-transfer loss for a net gain. And fouling can now be cleaned out more easily. They feared lower cooling-water velocity but it hasn't happened in spite of larger tube ID —probably because of lower friction losses. *ASME 60-WA-217*

To obtain complete text

Material for these abstracts comes from the following sources. Order complete publication from source, *not* POWER.

AIEE. Contact American Institute of Electrical Engineers, 33 W 39th St, New York 18, N. Y. Members 50¢; nonmembers $1.00.

AAAS. To be published in proceedings form. Contact American Assn for the Advancement of Science, 1515 Massachusetts Ave, Washington 5, D.C. Price not determined.

ASME. Contact American Society of Mechanical Engineers, 29 W 39th St, New York 18, N. Y. Members 50¢; nonmembers $1.00.

Maintenance and Steam Traps

. . . there's a relationship that goes far beyond trap maintenance alone

Good traps and good trapping have a greater effect on your maintenance costs than does trap maintenance itself. By that we mean that the right traps, properly selected and installed, and with the benefits of a preventive maintenance program, will save far more maintenance dollars than they will cost.

Under the pressure of spiralling maintenance costs, this thought becomes mighty important. Let's take a look at what it involves:

Proper Selection of Steam Traps

1. Be sure it's the right type of trap.

2. Be sure it's sized right and is for the correct operating pressure.

3. Be sure it's first rate in design and construction.

Proper Installation of Steam Traps

1. Install them so they are accessible for inspection and maintenance.

2. Install a test valve.

3. Use a union or unions.

4. Use a shutoff valve or valves.

5. Use a strainer ahead of the trap if dirt conditions are bad.

6. Use a by-pass only where continuity of service is imperative.

7. Standardize inlet and outlet connections.

Preventive Maintenance Program

1. Test trap regularly for proper operation. (Trap size, operating pressure and importance determine frequency.)

2. Inspect internal mechanism at least once a year.

You Get Indirect Benefits As Well

The direct benefits of the plan outlined are pretty obvious — good traps, properly selected, require less maintenance . . . testing and inspection prevents troubles that lead to maintenance.

However, this plan provides indirect benefits which reduce maintenance in other parts of the plant as well:

Good traps save steam and reduce the load (and consequently maintenance) on fuel handling and burning equipment and on ash handling equipment.

Good traps protect the system by eliminating water hammer and preventing the damage it can do.

Good traps discharge carbon dioxide before it can go into solution to form corrosive carbonic acid —less corrosion, less maintenance.

Good traps increase production to reduce the length of time equipment must operate or reduce the amount of equipment needed . . . either way maintenance is reduced.

How to Go About It (The Sales Pitch)

We admit we're prejudiced, but we don't think there is any better way to select steam traps than with the help of the 44 page Armstrong Steam Trap Book. Here in a single source is specific data on the selection and sizing of traps, how to install them for best results, and how to maintain them most economically.

The Steam Trap Book will also give you full information on the design and construction of Armstrong Inverted Bucket Steam Traps that offer these important maintenance-reducing advantages:

1. Armstrong Traps are dependable.

2. Armstrong Traps require no adjustments — go from full load to zero load automatically.

3. Armstrong Traps are self-scrubbing—ordinary dirt conditions can't hurt them.

4. Armstrong Traps have long-life parts — valve and seat are heat treated chrome steel — lever assembly and bucket are stainless steel.

5. Armstrong Traps have water sealed valves to minimize wire drawing and erosion.

Ask for your copy of the Steam Trap Book—there is no obligation. Then test Armstrong Trapping. If you are not completely satisfied with the results, you can return the traps for a full refund of the purchase price. You can't lose much that way. Call your local Armstrong Representative or Distributor, **or** write

Armstrong Machine Works
8126 Maple Street
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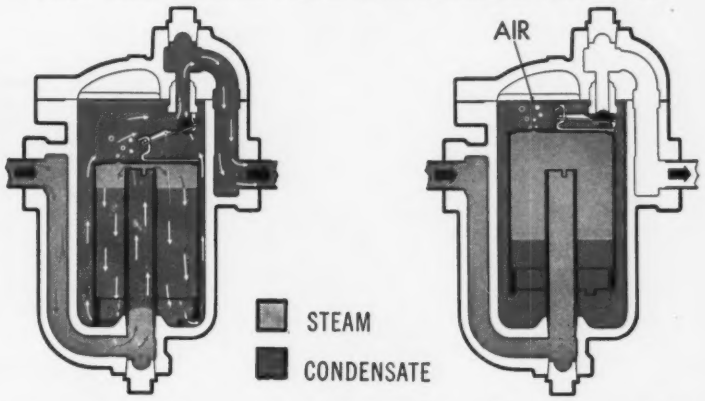
ARMSTRONG STEAM TRAPS

HERE'S THE STEAM TRAP DESIGN THAT CAN REDUCE YOUR MAINTENANCE PROBLEMS

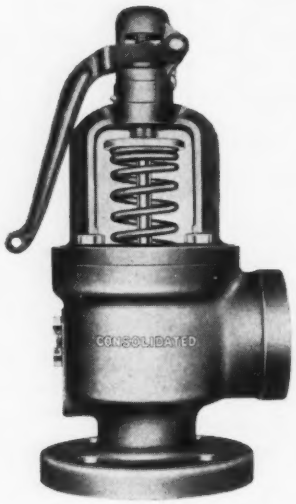


Trap open. Condensate entering trap has caused bucket to lose buoyancy. Weight of bucket times leverage pulls valve open. Air is discharged along with condensate.

Trap closed. Steam has floated inverted bucket; valve is held tightly closed by system pressure. Air entering trap passes through bucket vent and accumulates at top of trap.

cost

CONSOLIDATED SAFETY VALVES relieve overpressures automatically at extremely low cost per pound of steam discharged



Consolidated Safety Valve, Type 1511 Series. Cast iron body. Maximum capacity for saturated steam. Sizes: 1½" thru 6". Pressures to 250 psi. Temperatures to 450° F. ASME Standard. ASME Tested. National Board Certified.

conscious

Cost-conscious engineers provided maximum capacity in minimum flange size when designing the compact Type 1511 Consolidated Safety Valve. This innovation makes it practicable to reduce the number and/or size of safety valves per boiler. You also have the advantage of smaller, less costly discharge piping.

Fine blowdown adjustment, few working parts, and the positive tightness of optically flat seating add to the total economy of these tough, long-life valves. Get complete technical data and select from the Type 1511 Series the Consolidated Safety Valves that best meet your needs. Write for Bulletin 730.

Industrial distributors in all principal cities are backed by our convenient regional warehouses to give you prompt delivery on the Consolidated valves of your choice.

MANNING MAXWELL & MOORE INC. M&M TRADE MARK

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For more facts circle 258 on Reader Service card, p 103 **circle 259 on Reader Service card, p 103 ➤**

DEAN H. MITCHELL STATION NORTHERN INDIANA PUBLIC SERVICE COMPANY *414,300 kw—3 Units*

Power in Northern Indiana . . .

Abundant water supply and highly favorable transportation facilities have been important factors in the amazing development of heavy industry in the Northern Indiana area. Its steel production and oil refining are a major element in the American economy. Northern Indiana Public Service Company has played an important role in this growth and is gearing itself to meet the even larger future of this industrial concentration. The now completed Dean H. Mitchell Station and the new Bailly Station with a 193,000 kw unit scheduled for service in late 1962 are major steps in the company's program to provide adequate electrical facilities for the load to come.

FULL COLOR BROCHURE outlining the scope of Sargent & Lundy services will be sent on request.

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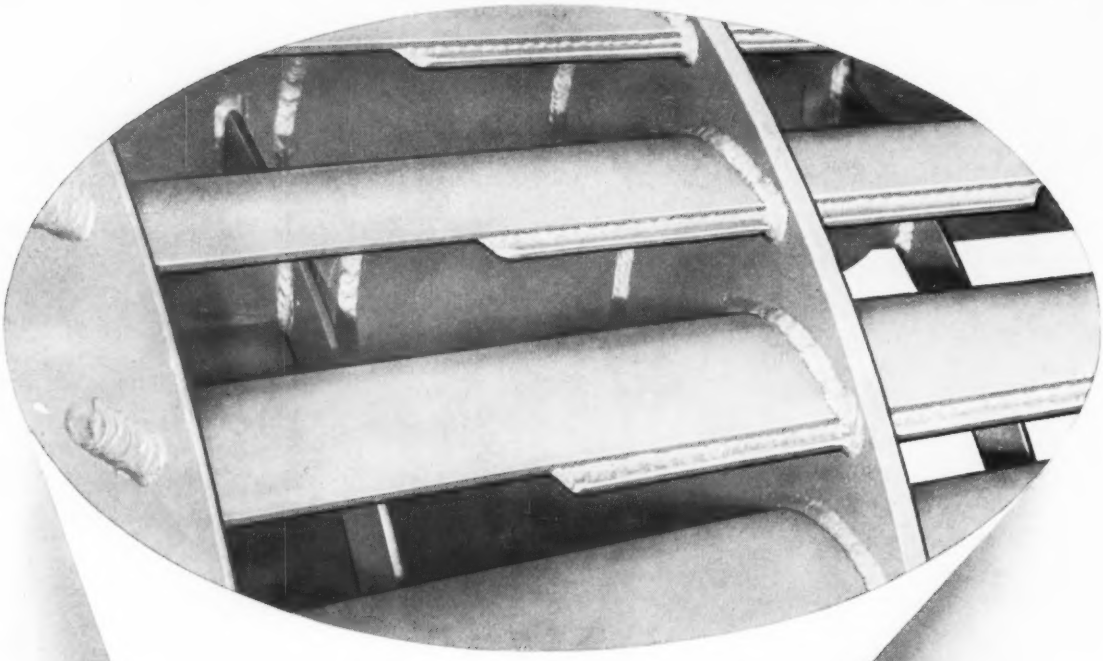


RIGHT

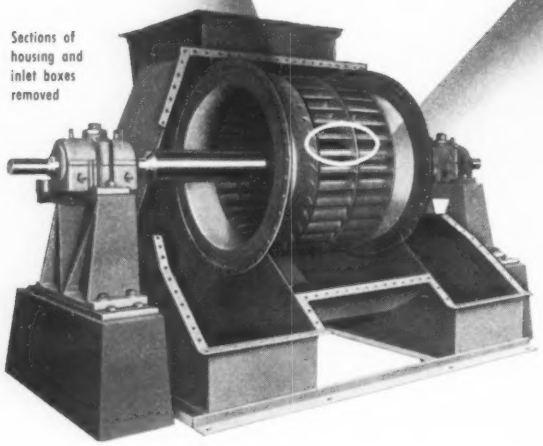
WHERE

THEY

BELONG . . . . . *wearing plates*

on the FACE

of the blades



Sections of housing and inlet boxes removed

Here's another feature you get only from Clarage. The Type DN Dynacurve induced draft fan, when equipped with wearing plates, has these abrasion-resisting steel plates welded to the *face* of the wheel blades.

Result: *extra* service life.

Don't settle for less. Choose the Clarage Dynacurve fan with its rugged wheel of 36 radially deep blades . . . minimum floor space and height requirements . . . bolted scroll liners for easy replacement . . . and numerous other distinctive features.

Contact our nearest office for complete data.

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CLARAGE FAN COMPANY

Kalamazoo, Michigan

SALES ENGINEERING OFFICES IN ALL PRINCIPAL CITIES • IN CANADA: Canada Fans, Ltd., 4285 Richelieu St., Montreal

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- **Study new equipment** described in this issue starting on p 116. Circle numbers on card corresponding to items listed
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New free literature

General equipment and key materials for systems engineering

• Instruments

101 **Electronic monitoring** system using error-checking circuits and solid-state components is subject of 8-p booklet. Applications include circuit breakers, motor-driven valves and pressure switches. Lynch Communication Systems, Inc

102 **Potentiometers** from ½- to 5-in. dia are detailed in 28-p catalog from DeJur-Amsco Corporation, Electronic Sales Div

103 **Vibration transducers** and exciters, strain gages and engine-monitoring equipment are illustrated and charted in 4-p bulletin K19A. The Korfund Company, Inc, Instruments and Acoustics Div

104 **H-p indicating rotameter** for 5000 psig at 200 F is topic of 4-p folder 131. Brooks Instrument Company, Inc

105 **Recorders** of amp, volts, watts, speed, pressure and position are explained in 4-p brochure. Applications include maintenance troubleshooting and operation monitoring. Esterline-Angus Instrument Company

106 **Electronic** data-processing-system parts are pictured in booklet from Philco Corp, Computer Div

107 **Gas chromatograph** which can be equipped for fast trace analyses is subject of 16-p booklet. Thermal-conductivity filament detector features fast-response full-flow cell geometry. Beckman Scientific and Process Instruments Div

108 **Frequency-response** fundamentals and terminology are covered in 12-p paper TM-6. Fisher Governor Company

109 **Automatic** programing systems for digital computers are discussed in 8-p brochure AR-1060 Coded illustrations of typical problems are included. Bendix Computer Div

110 **Computer** combines features of analog and digital to handle problems of partial differential equations, statistical iteration. Illustrated 20-p catalog also presents accessories of central computers. Computer Systems, Inc

111 **De receivers** convert transducer signals to pneumatic to drive recorder pen. Spec sheet E12-4 lists range, accuracy, response and power supply. Bailey Meter Company

112 **Control-linkage** systems are topic of 12-p revised bulletin P81-5. Drive and driven levers are

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charted and connecting links, bearings and shafts and cable connectors are discussed. Bailey Meter Company

113 **Flowmeter** kits are subject of 4-p pamphlet 10.1010. One kit is available with fully enclosed meter for pilot plant. Fischer & Porter Co

• Maintenance

114 **Zinc coating** can be brushed on iron or steel to provide rust protection. 4-p brochure pictures application and maintenance. Sealube Company

115 **Ground-chrome-ore** and other gunning mixes for furnace maintenance are described in spec sheet 38. H K Porter Company, Inc, Refractories Div

116 **Sulfamic-acid** cleaners are topics of rate booklet showing equipment-cleaning hookups. E I du Pont de Nemours & Co

117 **Chemical cleaning** of boilers, auxiliaries and heat exchangers is subject of 12-p booklet from Dow Industrial Service

118 **Foamed solvent** for cleaning equipment is discussed in 4-p pamphlet, Dow Industrial Service

119 **Caulking** joints in place with bitumen-rubber sealant is explained in 4-p bulletin. Surface preparation and handling the solvent - resistant sealant are chapters. Poly-Chem

120 **Powdered acid cleaner** for use in boilers, heat exchangers, water lines and pumps is subject of 4-p folder HEP-940. Hagan Chemicals & Controls, Inc

121 **Sludge collectors** for rectangular settling tanks are detailed in illustrated 28-p booklet 2746. Includes data on selecting tank size and ten states' standards for settling-tank design. Link-Belt Company

• Insulation

122 **Cost comparison** of insulations for underground-heat-distribution systems is subject of 4-p report issued by Ric-wiL, Inc

123 **Applications** of thermal insulations from 400 to 3000 F are described in revised 64-p catalog IN-244A. Temperature limit is given for all equipment. Johns-Manville Corporation

• Piping, valves, fittings and specialties

124 **Closed-circuit TV** camera to explore 4-in. dia and up pipes is watertight to depth of 10 ft and 5-psi pressure. Specs are given in catalog sheet available from GPL Div, General Precision, Inc

125 **Plastic pipe** is feature of 10-p brochure TR-270A — working pressures, flow chart and table of properties given. One chapter ex-

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NEW FREE LITERATURE continued.....circle key numbers, page 103, for your copies

plains cutting, connecting and installing. Johns-Manville Corp

126 **"How to measure and relate pipe, tubing and hose sizes"** is title of 16-p booklet 631 which supplies standard methods of measurement. Aeroquip Corporation

127 **Semi-rigid** plastic pipe is tabulated in 4-p pamphlet TR-273A. Applications include water and submersible-pump service. Johns-Manville Corporation

128 **Strainer** selection procedure is simplified in 12-p catalog 6008. Self-cleaning strainers are used for steam, air, gas and liquid service. Leslie Co

129 **Relief** and backpressure valves for high sensitivity at low pressures are described in bulletin 115. American Meter Company

130 **Full-flow dispensers,** one manually controlled and the other electric-solenoid operated, are detailed in spec sheet 41 from Trico Fuse Mfg Company

131 **Idea book** features special and unusual gage assemblies and solutions to common gaging problems in its 84 pp—available from Boice Gages, Inc

132 **Sizing sliding-gate regulators** and control valves is shown in 4-p chart bulletin JSC-1 from OPW-Jordan Corporation

133 **Ball valves** in combinations of metals, seats and seals from ¼ to 2½ in. and for pressures up to 400 lb are detailed in 8-pp section 5 of reference book 39. Homestead Valve Mfg Co

134 **Poppet type** air-control valves are presented in chart with coordinated air and solenoid pilot operators. Hoffman Valves, Inc

135 **Diaphragm** motor valves are described in bulletins 133 and 137. Tables show spring ranges, chamber sizes and valve-orifice constants and dimensions. American Meter Company

136 **Ductile-iron regulators** and control valves are illustrated in 4-p folder J-DI. Table compares steel, cast iron and red brass with ductile iron. OPW-Jordan Corporation

137 **Electrical** and mechanical positioners are used on devices regulating valves, throttles, machine tools such as air-hydraulic power cylinders and motorized screw drives. See bulletin 500A issued by Hanna Engineering Works

138 **Rotary joints** requiring no lubrication and working for single-flow or syphon steam service are topics of 4-p catalog 310B. Barco Mfg Company

139 **Detachable,** reusable hose fittings are covered in color-coded 8-p brochure. The Lenz Company

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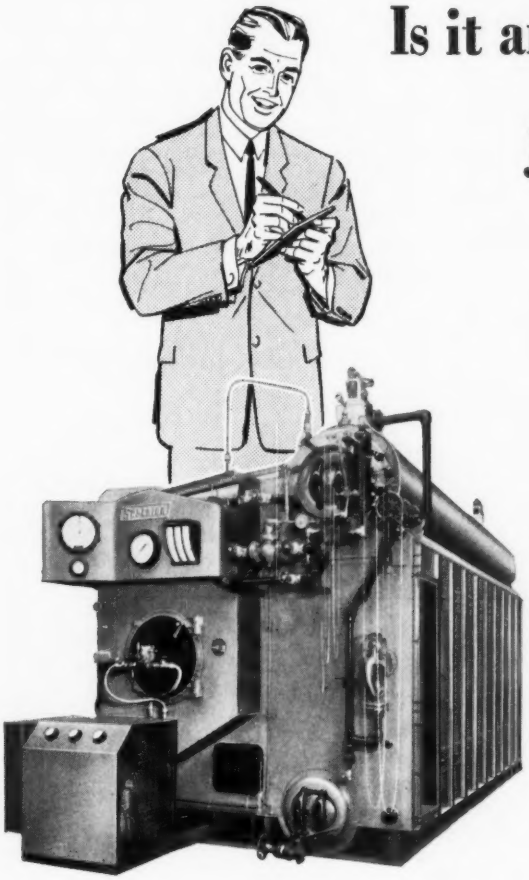
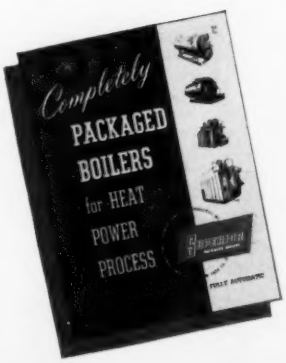


Is it an integrated package . . . or just a boiler with a burner? . . . or who stands behind its promised performance?

Ask specifically if the combustion safety controls and combustion control systems are engineered as part of the "packaged" boiler. Question the capacity of the forced draft fan . . . will the wind box provide air cooling for at least 80% of the boiler firing wall? Have all the critical components been engineered and assembled as part of the packaged boiler by the boiler manufacturer, or have they been sub-contracted, eliminating unit responsibility?

Every Superior Packaged Boiler is a completely integrated and engineered unit, backed by the undivided responsibility of its maker.

Since unit responsibility is basic to "packaged" boilers . . . and you pay for it, be certain you obtain it.



Superior Packaged Boilers of the water-tube type are designed for capacities from 4,000 to 61,000 lbs./hr., and are fired by gas, oil or both. The catalog illustrated provides condensed data on the world's most complete line of packaged boilers. Request catalog S-11

SUPERIOR COMBUSTION INDUSTRIES INC.
TIMES TOWER, TIMES SQUARE, NEW YORK 36, N.Y.
SUPERIOR PACKAGED BOILERS ®

For more facts circle 260 on Reader Service card, p 103

We bet millions on our couplings

When you buy a Fast's coupling, you can bet your bottom dollar everything was built on the spot, not assembled piece by piece from other suppliers. Koppers multi-million dollar manufacturing facilities are the most modern in the industry . . . with advanced program machines, highly accurate gear shapers, a complete forge shop.

For example, all Fast's Couplings are jig-drilled and jig-reamed for greater interchangeability of parts. Result: you get high-quality, smooth-running, long-lived units that are the choice of more equipment manufacturers than any other gear-type coupling.

KOPPERS COMPANY, INC., 1104 Scott Street, Baltimore 3, Md.

KOPPERS

FAST'S COUPLINGS

Engineered Products Sold with Service

For more facts circle 261 on Reader Service card, p 103

IMMEDIATE DELIVERY RIGHT NOW!

Recent rapid orders: A pair of 2700 kva package units to New Smyrna Beach, Florida for prime power! A doubled plant capacity at Grand Marais, Minnesota with a 1420 kva unit! A 1375 kva package to St. Cloud, Florida, on one week delivery!

We've got 'em: from 250 kva to 2000 kva, any voltage, available in stationary, mobile or portable models — in a hurry!

There's a Schoonmaker diesel for **your** job — no farther away than the phone on your desk.

If you're thinking diesel . . . GO SCHOONMAKER!

A·G·SCHOONMAKER COMPANY, INC.
ESTABLISHED 1898

WEST COAST: Dept. A, Foot of Spring St., Sausalito, Calif., ED 2-1490
EAST COAST: Dept. A, 50 Church Street, New York 7, N.Y. DI 9-4350

For more facts circle 262 on Reader Service card, p 103

Free literature

Begins on page 103A

140 **End fittings** for low-, medium- and high-pressure hose assemblies are shown in 4-p folder IEB-53. Aeroquip Corporation

• Heat exchangers

141 **Hot-water** converters are feature of 20-p bulletin 71. Metals and alloys for special fabrications are listed and method of selecting shell size and heating surface is included. Niagara Weldments Inc

142 **Heat exchangers** with straight tubes, externally packed floating tube sheets and single or 2-pass design are topic of 12-p booklet. Units come in 6-to-31-in. and 6-to-17-in. sizes. American-Standard Industrial Div

143 **Condenser** and heat-exchanger tube prices are listed in 6-p spec sheet. Scovill Mfg Company

Air-conditioning systems

144 **Dust-collecting** and -recovery systems are covered in 4-p folder. Materials handling, air pollution and recovery of material from waste gases are applications Buell Engineering Company, Inc

145 **Electronic** air cleaners for oil-mist control are subject of 8-p booklet 1450. Tables and diagrams are included. Sturtevant Div, Westinghouse Electric Corporation

146 **Panel type air filters** made of Dynel, 1- and 2-in. thick, are shown in 4-p bulletin A1. Union Carbide Development Company

147 **Heat-cycle** defrost units are described in 4-p bulletin. Specs and diagrams are included. Dunham-Bush, Inc

Electrical systems

• Distribution and protection

148 **Cable-suspension** system is topic of 4-p catalog. Sheathing may be placed in tension. Perfect-Line Mfg Corporation

149 **Operating** and safety requirements of service-entrance equipment is detailed in 6-p bulletin 601. Chapters on current-carrying efficiency, manual-switching facility and speed and capacity of short-circuit interruption are included. Pringle Electrical Mfg Co, Inc

150 **Large distribution transformers,** single and 3-phase units, are described in 12-p catalog GEA-7153. Weight and dimension tables included. General Electric Company

151 **Drawout** motor controller, 2000- to 5000-v range, is available for

Undetected flame failure can cause costly interruptions, do serious damage to expensive equipment and endanger lives. To prevent such loss, Honeywell has developed an ultraviolet flame detector that won't be fooled, because it positively differentiates between flame and hot brick.

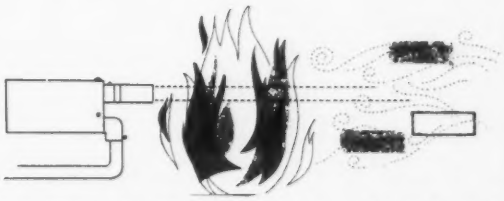
This flame detector senses only the flame!

No more hot refractory hold-ins!

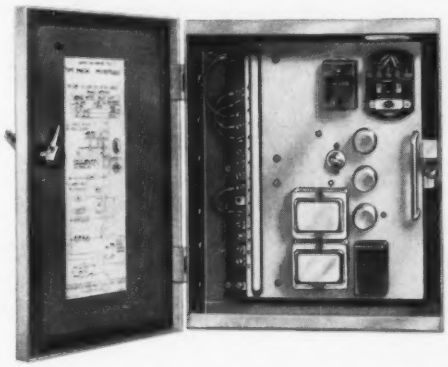
For the first time, you can be absolutely sure that fuel delivery will be stopped in the absence of flame. Honeywell's C7012A Ultra-Vision* Flame Detector employs an amplified ultraviolet signal to positively distinguish between an actual flame (ultraviolet rays) and a hot refractory (infrared rays). This revolutionary new device represents a major breakthrough in scientific flame detection.

Not only is the Ultra-Vision Flame Detector compact. It also simplifies flame supervision of both single and multiple burners because, not being sensitive to a hot refractory, it can be aimed at each individual flame in the most convenient way. It is the only control device on the market that offers you this advantage.

Is it economical? This amazing new flame detector will actually save you money in simplified installation and maintenance. Wiring is less expensive in this system than in a lead sulphide cell. It is easier to install because hot refractory can be ignored. And there is no further need for flame rod replacement.



Honeywell's new Ultra-Vision Flame Detector sights the flame of all fuels, but is not affected by hot brick. It does a more effective job on single burner pilot and main flame installations. And now, for the first time, multiple burner installations can also be monitored safely.



Honeywell's new R4075 Protectoglo* Flame Safeguard Relay features a "maximum-safety" self-checking circuit to continuously supervise constantly burning industrial burners. The mounting cabinet has all-voltage terminals and a quick-disconnect control base that allows this electronic flame safeguard to be completely removed without disconnecting any of the wiring.

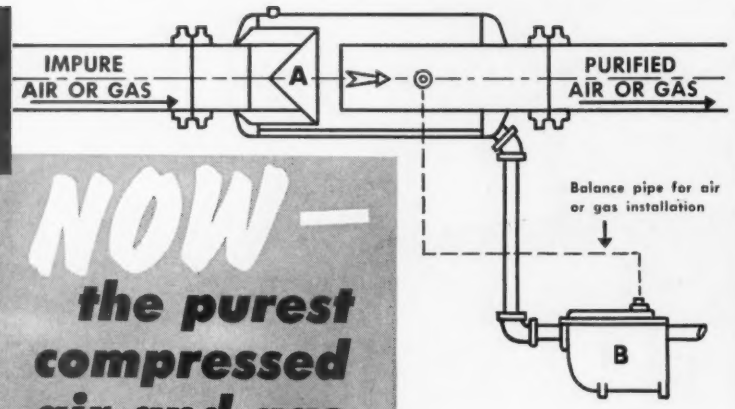
Trademark

Honeywell

First in Control

SINCE 1885

For more facts circle 263 on Reader Service card, p 103

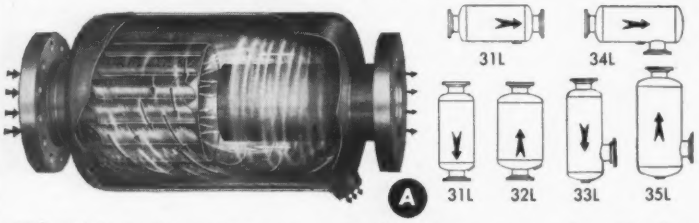


NOW— the purest compressed air and gas is yours with this W-A equipment

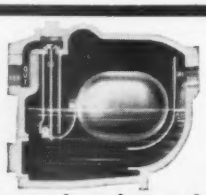
GUARANTEED TO REMOVE 99% OR MORE OF ENTRAINED MOISTURE AND SOLIDS

Where pipe lines carry compressed air and gas, liquids and solids are generally entrained in the gas stream. Wright-Austin 30L Series Separators can be used to remove foreign matter on a wide range of applications. For operating pressures to 5000PSIG. Line sizes to 24". Here are some typical applications:

REMOVE
- —oil and water from compressed air supply lines
- —oil and water on compressed air service at outlet of inter-cooler and after-cooler equipment.
- —oil, moisture and tar between stages in coke oven gas compressors
- —oil and water from CO_2 gas lines
- —oil and water from hydro-carbon lines
- —entrainment from vapor lines following evaporation



This Wright-Austin separator employs centrifugal force to remove impurities from steam, air or gas flow. The pressure drop is extremely low. Type 31N, as well as other models shown, is light weight, compact and sturdily constructed according to ASME code.



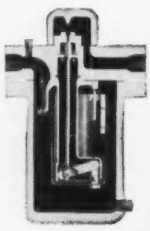
23-AC TRAP (0-125 PSIG)

Separated condensate flows to trap. Drainage is automatic. Particularly adapted where cold, gummy, emulsified cylinder lubricants make ordinary traps inoperative.

B

101-AC TRAP (0-600 PSIG)

Cast steel body, cover and bonnet. Designed for draining condensate where high pressures are involved. Internal mechanism all attached to cover for easy service.



WA 1894 **WRIGHT-AUSTIN COMPANY**
3245 WIGHT STREET • DETROIT 7, MICH.

WRITE FOR NEW CIRCULAR 809-A

Free literature

Begins on page 103A

squirrel-cage, wound-rotor and synchronous motors—subject of 8-p brochure 14B9739. Allis-Chalmers Mfg Company

152 **Motor center** for controlling two or more motors from one location is topic of 8-p catalog. Unit is permanently wired to vertical cable bus for safety. Rowan Controller Company

153 **Current-limiting** power fuses rated 600 to 34,500 v are detailed in 8-p booklet. Components and mounting arrangements are featured. General Electric Company

154 **Modular-designed rotary** switches, hp rated for motor control, are topic of 4-p brochure. Switches can be supplied in ratings from 20 to 200 amp. American Solenoid Company, Inc

155 **H-p rated** heavy-duty metal-cased and double-break switches are listed in catalog 30-1. 16 pp include NEMA definitions of precision snap-acting switch terms. Unimax Switch Div, The W L Maxson Corporation

156 **Contactor** using glass polyester insulation is designed for controlling large motors and for primary switching of induction-furnace transformers. 6-p bulletin 14B9740 gives details. Allis-Chalmers Mfg Company

• **Application**

157 **Dielectric-breakdown** sets, heavy duty and portable, are among instruments for testing electrical equipment mentioned in 12-p catalog 10-1.3. Corona-detection and measurement instruments, kilovoltmeters and h-v power supplies are included. Associated Research, Inc

158 **Vertical** synchronous motors from 250 hp for pump drives are topic of data sheet 1100-PRD-247. Motors are available at 1100 rpm. Electric Machinery Mfg Company

159 **Stator insulations** are feature of open motors illustrated in 12-p bulletin 05-51B9040B published by Allis-Chalmers Mfg Co

160 **Motors,** 23 types, are feature of 8-p brochure 2651. Available ratings, enclosures and modifications are illustrated. The Louis Allis Company

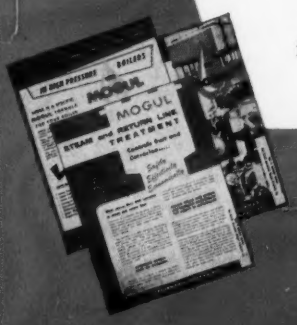
161 **Fractional** hp motor, design and construction—objects of 8-p bulletin B-2514. Unit offers new ventilation system and reduced weight. Reliance Electric and Engineering Company

162 **Hydrostatic-rupture** test results are charted in 4-p folder 236. Cast-aluminum-alloy housings were tested for explosionproof qualities. The Adalet Mfg Co

continued

National Alfalfa Dehydrating and Milling Company, the World's Largest Alfalfa Processors, has STANDARDIZED on MOGUL water treatment services in 34 plants . . . .

NATIONAL'S network of plants covers the nation's principal alfalfa producing areas. These plants guarantee feed manufacturers a complete range of quality dehydrated alfalfa, available 12 months of the year. When National standardized on MOGUL water treatment and service they gained these important advantages: **obtained maximum water treatment results, full responsibility with one source through the services of the local Mogul Representatives—and reduced treatment costs.** Mogul offers this kind of national service that includes surveys, periodic inspection, consulting service and water analysis. All of these services are supplied free of charge and results are guaranteed. Write for complete information.



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Products Company
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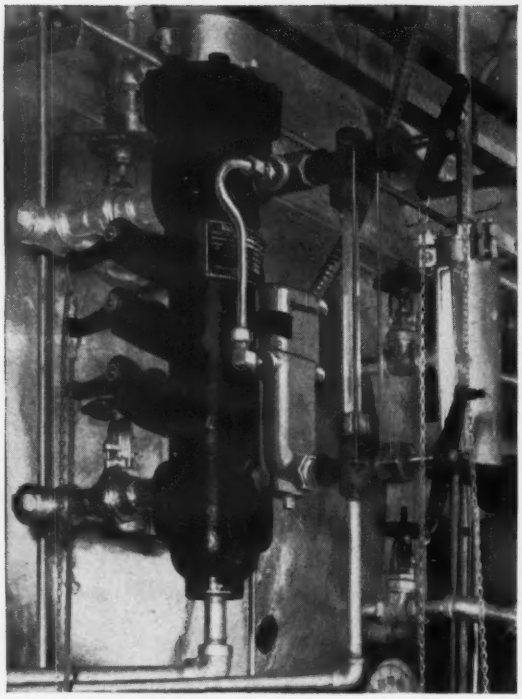
SPECIALISTS IN INDUSTRIAL WATER TREATMENT FOR OVER 45 YEARS



Low Cost Protection

that helps you to avoid water level accidents

What Reliance Levalarms can do for you:

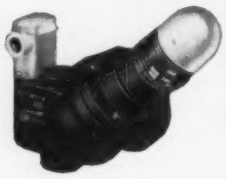
1. operate alarms — low or high water level.
2. actuate fuel cut-out — single or dual.
3. control pumps — start and stop.

Both low and high liquid levels in boilers and various tanks and vessels need "watch-dog" service, as you know. Reliance Levalarms help maintain control by *signalling* dangerous conditions or by actually *motivating* fuel cut-outs, pumps, etc.

Illustration above shows Levalarm EA-15R on a water column. It can serve as fuel cut-out, or cut-out and alarm. Under the cap on top of the column are terminals of electrodes that extend into the column. They form a Levalarm capable of handling a combination of duties such as listed above.

Other members of the valuable "Levalarm Family" are shown at right. Ask for more complete information on these versatile devices that insure positive, economical warnings and control.

EA-7,
float-actuated switch;
low and high alarm.



EA-100P,
float and electrodes;
single or dual fuel cut-out.

EA-101,
electrode; alarms, fuel
cut-out or pump control.

The Reliance Gauge Column Company
5902 Carnegie Avenue • Cleveland 3, Ohio

Reliance®

BOILER SAFETY DEVICES

Free literature

Begins on page 103A

163 **"Power** for your future" is title of 8-p pamphlet. A condensation of studies or requirements for 1970 and 1980, the booklet tells about plans to meet these power needs. Available at 4¢ per copy from Edison Electric Institute

164 **Dc and ac power supplies** including rectifier devices are illustrated in 16-p pictorial report published by A O Smith Corporation

Steam and hot-water systems

165 **H-p boiler** water gages and valves are covered in data sheet 393. Available up to 18 in. and 1500-lb water-steam pressure. Jerguson Gage & Valve Co

166 **Firebrick** for boiler linings is detailed in spec sheet 555. Chemical analysis, hot-load deformation and linear change are discussed. J H France Refractories Company

167 **Control systems** for boiler cleaning are described in 14-p booklet. Specifications and possible control-panel combinations are features. Diamond Power Specialty Corp

168 **Boiler automation,** its status and future, is topic of 8-p study G-101. Pros and cons are weighed. Babcock & Wilcox Company

169 **"Design fundamentals** for combustion air blowers" is subject of 8-p reprint. Included are performance curves and illustrations on selection of gas boosters and blowers. The Spencer Turbine Co

Fluid-handling systems

- **Air compressors**

170 **Air dryer** dew-point chart is given in spec sheet 9300. Unit has rated capacity of 10 scfm. Hankison Corporation

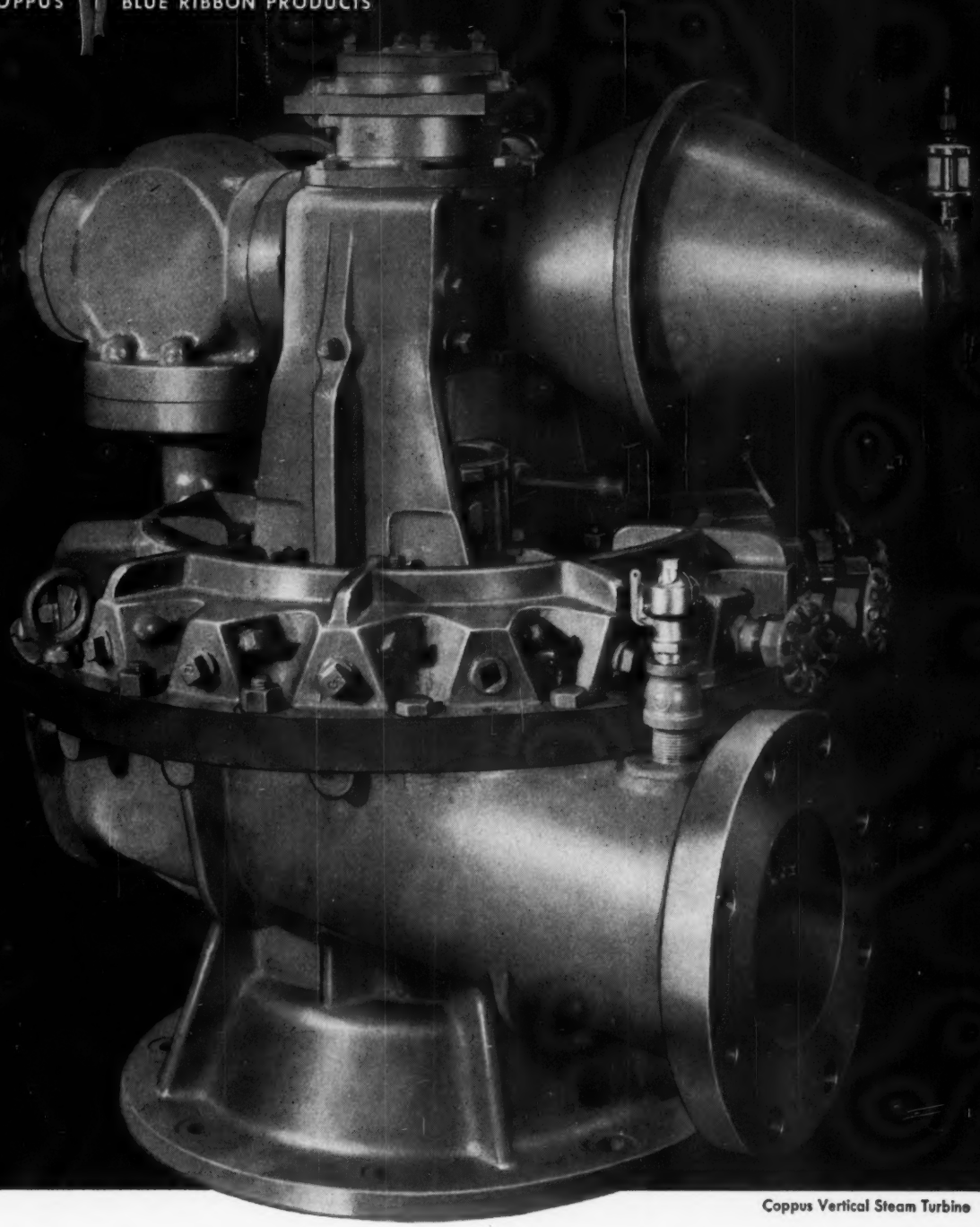
171 **Rotary-compressor** 24-p bulletin ACO 100.4 features performance: capacity to 21,000 cfm and pressure to 250 psig. Design, construction and application are chapters. Fairbanks, Morse & Company, Compressor Div

172 **Jet compressors,** fixed nozzle, manually or automatically controlled spindle, are described in 16-p catalog 4F. Nomograph helps determine weight ratio of secondary to primary gas. Schutte and Koerting Company

- **Water treatment**

173 **Disposable-cartridge** demineralizers up to 1500 gph are shown in 6-p folder 154. Applications in-

COPPUS BLUE RIBBON PRODUCTS



Coppus Vertical Steam Turbine

THE MARK OF QUALITY — There's no better test of a turbine's quality than performance. And the new, ruggedly designed, power-packed Coppus Turbines pass all performance tests with top honors! Small wonder. Coppus quality is literally designed and built into them. Their super stamina is the end-product of painstaking craftsmanship, finest materials and methods, thorough testing and control. Each truly deserves its Blue Ribbon . . . assurance of *complete* reliability.

Typical Coppus Blue Ribbon features are: *totally enclosed governor . . . totally enclosed and independently operated safety trip . . . easily replaceable packing and bearings . . . multiple steam nozzle control . . . brake rim for added safety . . . wide bucket "L" type wheel (optional) for minimum water rate.* You get higher efficiency operation . . . less down time . . . lower maintenance costs.

Coppus Turbines are built to customers' specifications, including API and NEMA standards. Send for Catalog 200. Get complete details on Coppus Turbines. Sizes from 1 HP to 250 HP. Write COPPUS ENGINEERING CORPORATION, 164 Park Avenue, Worcester, Mass. Sales Offices in *Thomas' Register*.

COPPUS
STEAM TURBINES

For more facts circle 267 on Reader Service card, p 103

For the Savannah Plant
of
SOUTHERN NITROGEN CO.

"...excellent trouble-free service" against SURGE PRESSURES

Handling hot potassium carbonate requires safeguarding pumps and piping systems against dangerous pressure surges. Eight Williams-Hager Silent Check Valves—similar to the one shown at right—guard Southern Nitrogen's Savannah Plant by operating *instantly* when flow reversal starts or when flow is zero.

Write for Bulletins: #654 on Valves; #851 on Cause, Effect and Control of Water Hammer; #659 on Pressure Loss Tests.

WILLIAMS • HAGER
Silent
Check Valves

The Williams Gauge Company, Inc.
160 Stanwix Street · 2 Gateway Center
Pittsburgh 22, Pa.
Our 75th Year • 1886-1961

Free literature

Begins on page 103A

clude electronic, nuclear and pilot-plant operations. Barnstead Still and Sterilizer Company

174 **Selection** of water-treatment equipment for high-makeup boilers in 600-to-1250-lb range is covered in 10-p article T-183. Case histories of two plants and treatment and testing methods are discussed. Graver Water Conditioning Company

• Pumps

175 **Impervious-graphite** centrifugal pumps with capacities to 140 gpm and heads to 67 ft are topic of illustrated 4-p bulletin S-7253. National Carbon Company

176 **High-capacity,** 3550- and 1750-rpm submersible pumps for industrial water-supply systems are subject of 8-p brochure B1400. Sumo Pumps, Inc

177 **Double-suction** centrifugal pumps providing capacities from 100 to 6400 gpm are shown in 16-p catalog 721.6. Pumps are available with choice of grease- or oil-lubricated bearings and in stainless steel or ductile iron. Goulds Pumps, Inc

178 **Leakproof chemical pumps** with automatic thrust balance and oil-filled stator cavity are detailed in 4-p folder 2050. Cross-section and performance curves of canned pumps are included. Chempump Div, Fostoria Corp

179 **Regenerative-turbine-pump** selection, performance and mechanical data are given in catalog 101. The Roy E Roth Company, Turbine Pump Div

180 **Plunger** pumps for metering against pressures to 1200 psi are detailed in 8-p booklet 420.100. Pump features unitized construction with enclosed drive. Wallace & Tiernan Inc

• Controls

181 **Stainless-steel** liquid meter, 1-½ in., for corrosive and noncorrosive liquids is topic of 4-p circular. Neptune Meter Company

182 **Turbine type** flow transducer is subject of 4-p folder. Design permits hydrodynamic balance of rotor without using thrust bearings. Francisco Engineering Co

183 **Sodium** in high-purity water can be determined to a lower limit of 0.0002 ppm with flame photometer. Technical bulletin 68 covers sample handling and flame housing in its 2 pp. Cyrus Wm Rice & Company

184 **Position-transmitter** spec sheet P99-10 gives air consumption and supply and transmitting distance. Bailey Meter Company

...on the
JOHNSON
HORIZONTAL
STEAM GENERATOR

The "good word" to pass is: The Economical, efficient, automatic source of constant pressure and uniform temperature steam of the Johnson Horizontal Steam Generator . . . Built to A. S. M. E. Specification in sizes up to 33 H.P. Check these features below to assure trouble-free service with the least possible Maintenance.

- Fuel—Gas, Oil or Combination Gas and Oil Firing.
- Design—Modern, Efficient.
- Construction—A. S. M. E. Standards.
- Inspection—Fully tested under the most rigid conditions.
- Standard Pressure—100 lbs.
- Extra High Pressure up to 250 lbs.
- Easy Adaptability—to boiler feed and return condensate units.

Free—for full details, send for Bulletin #8C and #4H.

"Engineered Steam at its best, with over 50 years of Experience at your disposal!"

mko
mears kane ofeldt inc.
DIVISION OF S. T. JOHNSON CO.
Church Road, Bridgeport, Pa.

circle 268 on Reader Service card, p 103
circle 269 on Reader Service card, p 103

Get 31% more filming action with Dearborn's Super Filmeen®

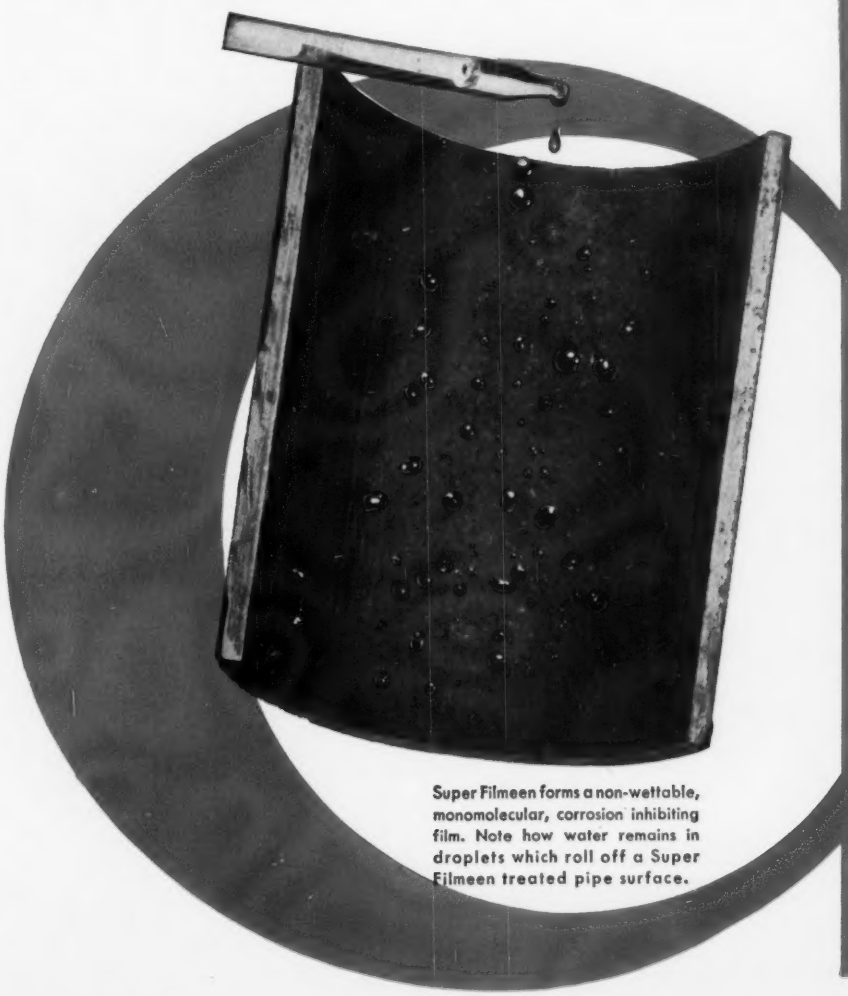
In either flake or emulsion form, Super Filmeen—a development of Dearborn's research laboratories—has been proved 31% more active than ordinary octadeclyamine acetate . . . is not subject to dehydration at super-heated steam temperatures . . . will not hydrolyze to acetic acid . . . remains alkaline in feed solutions.

Prevents corrosion due to carbon dioxide or oxygen . . . effective when fed to boilers, feed or steam lines . . . removes deposits and corrosion products from heating surfaces and return lines . . . compatible with most treatment chemicals.

Update *your* condensate system protection with Super Filmeen. Call your Dearborn engineer or write for detailed Technical Bulletin today!

DEARBORN CHEMICAL COMPANY

General Offices: Merchandise Mart, Chicago 54 · Dallas · Des Plaines, Ill. · Ft. Wayne · Honolulu Linden, N. J. · Los Angeles · Nashville · Omaha · Pittsburgh · Toronto · Havana · Buenos Aires



Super Filmeen forms a non-wettable, monomolecular, corrosion inhibiting film. Note how water remains in droplets which roll off a Super Filmeen treated pipe surface.

pioneer in the science of corrosion control since 1887

dearborn

For more facts circle 270 on Reader Service card, p 103

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in doing a better job for your company?

in preparing for that bigger job when it comes?

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Company..... Number of Employees.....

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OR

Use this coupon, enclosing your check or money-order made out to McGraw-Hill Publishing Company.

PPG Fiber Glass Pipe Insulation is slit lengthwise, slips easily on to pipe. Delaware Insulation Company installed 15,000 ft of PPG Pipe Insulation in the new Wilmington High School, reported excellent working characteristics.

"We can install PPG Fiber Glass Pipe Insulation 15% faster than other pipe insulating materials"

says Mr. Anthony Kotowski, foreman, Delaware Insulation Company, Wilmington, Delaware

"A good worker can insulate 200 feet of pipe in one work day. But with PPG Pipe Insulation, he can insulate 230 feet in the same amount of time," reports Mr. Kotowski. "This helps us maintain tight construction schedules and saves money, too!

"We like PPG Fiber Glass Pipe Insulation because it's flexible and workable. We bend it around pipe hangers, mold it to shape easily, smooth it, then fasten and bind it," continued Mr. Kotowski as he discussed the PPG installation in a Wilmington High School. "You can't do that with other insulations. They're too brittle, require cutting, and sometimes break when you're working with them.

"PPG Pipe Insulation is easy on the hands, and it's not attacked by rodents. Of all the insulations on the market, PPG gives the neatest, quickest job."

GET TOP RESULTS WITH PPG

Fast installation, excellent thermal insulation, long service life, low maintenance . . . all these advantages are yours with PPG Fiber Glass Pipe Insulation. It's available in a full range of sizes, with or without facing.

For full information, contact your nearest PPG Fiber Glass Sales Office, or write *Pittsburgh Plate Glass Company, Fiber Glass Division, One Gateway Center, Pittsburgh 22, Penna.*

FIBER PPG GLASS PITTSBURGH PLATE GLASS COMPANY

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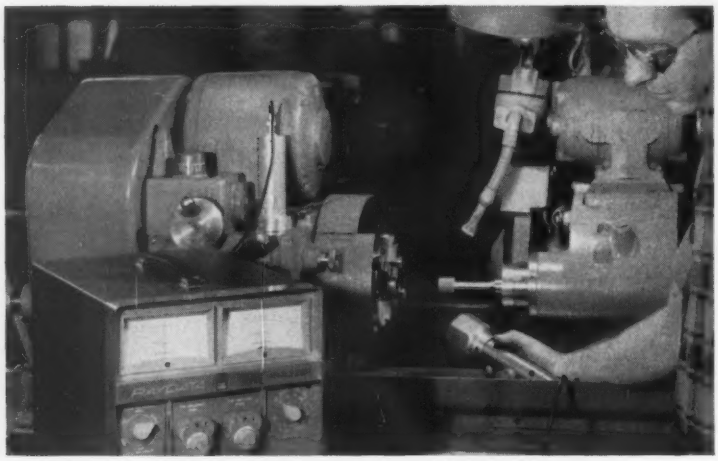
For more facts circle 272 on Reader Service card, p 103

For more data on these developments, circle key numbers on Reader Service card, p 103

Plant equipment news . . . Your



Analyzer studies vibration sources

1 • Vibration-signal analyzer-balancer is designed to study vibration in machinery, buildings, pipelines. Modular construction and transistorized circuitry promise reliable operation using little power.

You select voltage input manually for various measurements. Range from 50 microvolts to 100 v lets you measure amplitude from 5 micro-in. to 100 millinches peak to peak, frequency from 3 to 10,000 cps, velocity from 50 micro-in. to 100 in. per sec at ± 2% accuracy. Model 41 analyzer, velocity pickup and strobe light cost under $2000.—RayData Corporation

Mobile welding system packages on truck

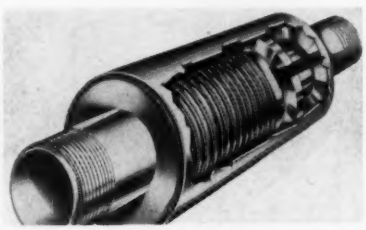
2 • Complete multiarc welding system on wheels comes packaged in a truck. It's ready to supply constant-potential dc to 30 welders minutes after arriving at the job, reducing setup and takedown time.

One plug-in primary connection energizes the system. Silicon-rectifier source rated 75 v, 1500-amp-dc continuous, 2250 amp for 2 min, supplies power through 400-amp welding-control stations. 24 of the 30 stations mount on the truck, 6 are portable.—J B Nottingham & Co, Inc

Ventilation fan provides supply, exhaust at one time

3 • Dual-function package is said to simplify air handling, providing simultaneous supply and exhaust. Versatile fan handles general or industrial ventilation at temperatures to 2000 F. Heart of system: a single cast-aluminum fan wheel. Inner part of wheel circulates air in one direction, outer portion routes it in the opposite direction.

Advantages, according to maker: only one opening is needed. One motor, one drive, one starter are involved, cutting first and maintenance costs. Installation time drops. Fresh-air supply is drawn from above the roof level where atmosphere is cleaner; it can be louver-directed or ducted.—Clarage Fan Co

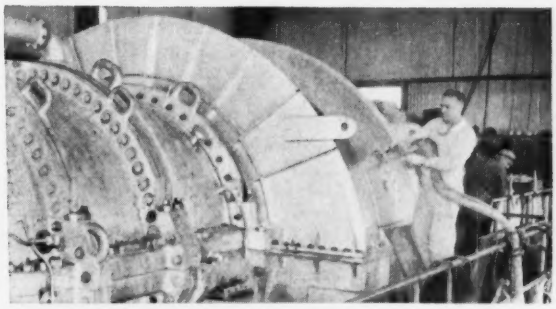


Expansion compensator

4 • To tackle corrosive service, expansion compensators are now made entirely of corrosion-resistant stainless steel. They're designed to absorb thermal growth in pipes from ¾ to 3 in. Screwed, welding or flanged ends, heavy-duty bellows, anti-torque mechanism and protective shroud are all stainless, to work under corrosive conditions at pressures up to 175 psi, temperatures as high as 750 F.

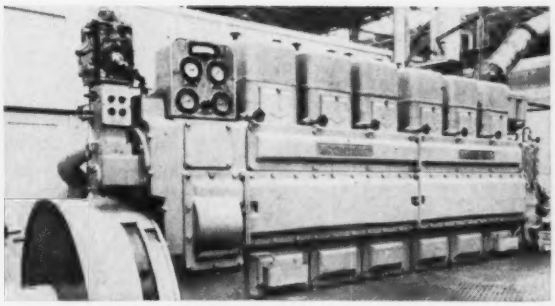
Compensator is also available in bronze, to use where dissimilar metals might present corrosion problems. Here working pressures run to 150 psi, temperatures to 406 F—unit comes with male-thread and sweat ends.—Flexonics Corporation

information center for new products and materials



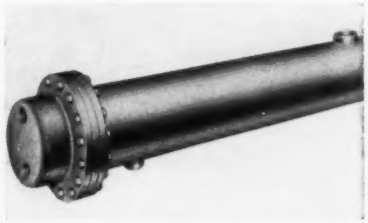
Spray-on turbine insulation cuts costs

5 • Sprayed asbestos is now available to insulate steam and gas turbines. Several inches of blue asbestos are sprayed directly onto castings of turbine's housing—no surface treatment required. Major benefit is significant cut in cost, maker states. Application takes ¾ the time of conventional methods.—Keasby & Mattison Co



Dual-fuel engines bid for many jobs

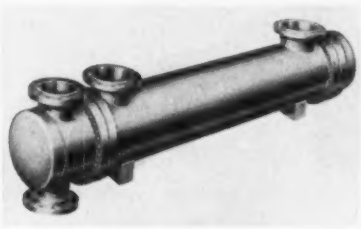
6 • Engines run on diesel oil or combustible gas with some diesel fuel added for ignition. They come in two series: high speed, 47 to 140 hp; heavy duty, 150 to 500 hp. High diesel compression ratio of 14:1 maintains efficiency. Both types show rising torque curve with decreased speed.—Kromhout Motoren Fabriek



Hot-water converters

7 • Standardized hot-water converters come in 114 models in 2- and 4-pass arrangements. They're designed for space-heating service.

Available steam inlet pressures: 0, 2, 5, 10 or 15 psi; temperature ranges: 160 to 180, 180 to 200, 190 to 210, 200 to 220 F. Standard shells, flanges, nozzles, drains, tube supports and cradles are made of welded flange-quality steel. U tubes of the removable bundles are seamless drawn Admiralty or copper. Or units can be specially fabricated from various metals or alloys for unusual applications.—Niagara Weldments Inc



Heat exchangers

8 • Standard components are assembled into custom-built heat exchangers for specific chemical- and industrial-processing requirements. "Selective-assembly" design gives wide choice of components, saves delivery time and cost, maker claims.

C-200 exchangers will handle any combination of liquids and gases. They can be used as heaters, coolers, condensers or vaporizers. Shell sizes: 8 to 42 in. Shellside and tubeside design pressures range from 75 to 300 psi, design temperature is 400 F—or as high as 650 F in carbon steel.—American-Standard Industrial Div

Graphite heat exchanger gives true counterflow

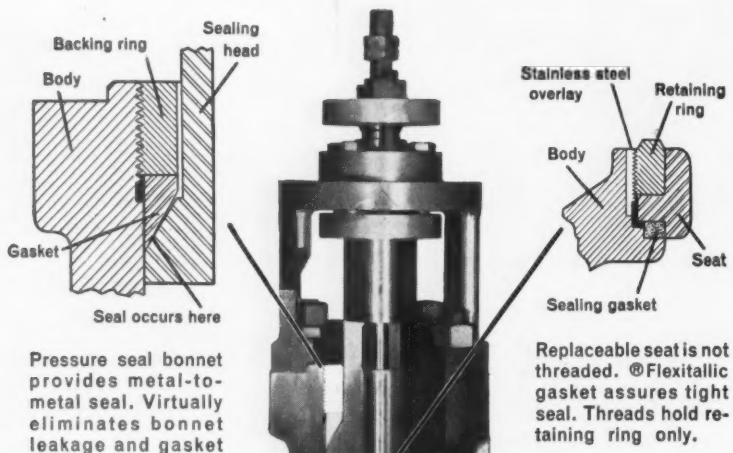
9 • Compact-block heat exchanger made of impervious graphite is said to provide true counterflow. Fluid flow on both sides touches graphite only—so unit is suited to handling heat transfer between corrosive liquids and gases, as well as more-conventional heating or cooling corrosive solutions with steam or H_2O. You can use from 1 to 6 center blocks, each 24-in. long, to give a range of heat-transfer area of 35.2 to 176.7 sq ft for the 3-pass model. Adding center blocks increases capacity as required.

Exchanger has 13x21-in. cross section, operates at steam pressures to 50 psig, temperatures to 338 F. It's stocked in 1-, 3- and 5-pass models with equal areas and number of passes on each side, can also be supplied with unequal passes—for steam heating and condensing, for example.—National Carbon Company

For more data on these developments, circle key numbers on Reader Service card, p 103

ROCKWELL-REPUBLIC

High pressure globe valve withstands pressure drops up to body ratings



Pressure seal bonnet provides metal-to-metal seal. Virtually eliminates bonnet leakage and gasket problems.

Replaceable seat is not threaded. ®Flexitallic gasket assures tight seal. Threads hold retaining ring only.

Rockwell-Republic high pressure globe valves are available in 1½", 2", and 3" sizes for 1500, 2500 and 4500 psi standards. In addition to removable seat and pressure seal bonnet, these valves are available with bolted bonnets and quick-change trim. For more information about this and other Rockwell-Republic components and systems, just mail the coupon below. RF-23

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Republic Flow Meters Co. *(Subsidiary of Rockwell Manufacturing Company)*
2240 Diversey Parkway, Chicago 47, Illinois

Equipment news

Begins on page 116

"Slim-Jim" capacitor

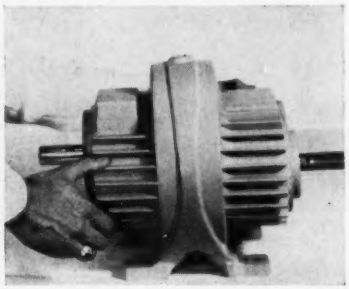
23 • Power capacitors, 50 and 100 kvar, are rated 2400 to 7960 v, 60 c, single phase. Use single- or double-bushing units in sub stack racks on utility transmission and distribution systems. The 50-kvar unit weighs 92 lb, has case 15½-in. wide, only 4½-in. deep. The 100-kvar unit weighs 175 lb, is 13½-in. wide, 4½-in. deep and 41½-in. high. Units meet standard horizontal NEMA mounting dimensions of 15⅝-in. on 7⅛-in. or 8-in. centers. — Federal Pacific Electric Company

Just circle key numbers on the Reader Service card, page 103, to get complete product story

Dielectric test set has motorized output

41 • H-v-ac test set has motorized, continuously adjustable output of 0-to-15 kv and 2-kva capacity. Dual-scale kv meter is connected directly at output for accurate voltage indication; motorized output control gives uniform measure of output-

voltage rate of rise. Controls include line switch with pilot lamp, circuit breaker and kv-meter range-selector switch.—Peschel Electronics, Inc



Transmission features instantaneous reversing

39 • 5-hp unit reverses instantaneously in 0.2 sec even under worst conditions, manufacturer says. Developed primarily for high-speed load positioning, reversing and sequencing in industrial servo and automated systems using card or tape control, transmission can also be used on machine tools to change speed and direction of cutting tools. Unit has built-in amplification and low power requirements.—Airborne Accessories Corp

Just circle key numbers on the Reader Service card, page 103, to get complete product story

Conveyor scale weighs, measures, controls flow

22 • Automatic unit is designed for control application in any operation where bulk materials are transported to conveyor galleries. You can also adapt it to other operations: rationing or blending additives, segregation control, determining bulk density, grade, control of feed rates to processing equipment. Remote indicating and recording instrument mounts in any convenient location up to 500 ft from carriage.—Ramsey Engineering Company

continued

ROCKWELL-REPUBLIC

V-5 gauges combine small size with big-gauge readability

TRY THIS "CUTOUT TEST"

For a true demonstration of the readability of Rockwell-Republic V-5 gauges, cut out the actual-size photo at the right. Mount it on any wall or panel board. Step back and see how easily the scale can be read, even from 10 or 12 feet away!

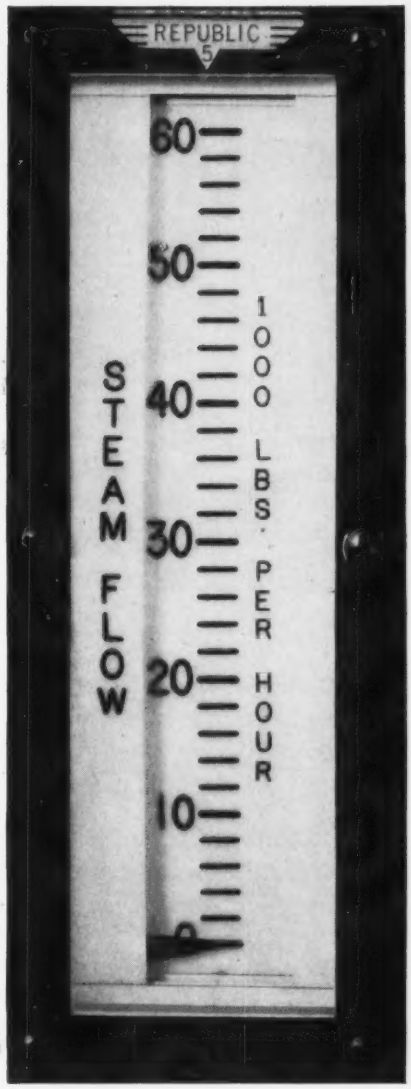
BIG-GAUGE ACCURACY, TOO

Compact V-5 gauges are equipped with electric receivers or full sized diaphragms, bellows, and helixes for maximum accuracy and sensitivity. Yet these Rockwell-Republic gauges require one-fourth the panel space needed for standard gauges.

GROUP MOUNTING INCREASES VERSATILITY

As many as eight gauges can be grouped in a single mounting case. Types can be mixed to meet individual panel requirements. Mounting is simple, too. Just a panel cutout is required in most cases.

There's a V-5 gauge for almost every process measurement. Mail the coupon today for the 12-page bulletin on these easy-to-read gauges, and for available literature on other Rockwell-Republic instruments, controls, and valves. RF-22



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Republic Flow Meters Co. *(Subsidiary of Rockwell Manufacturing Company)*
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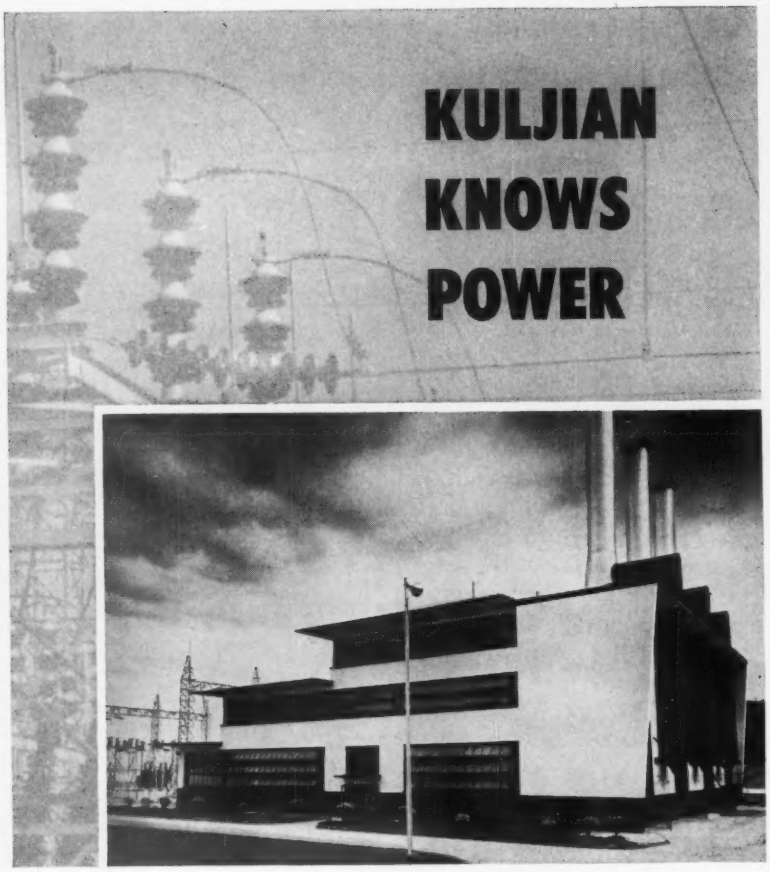

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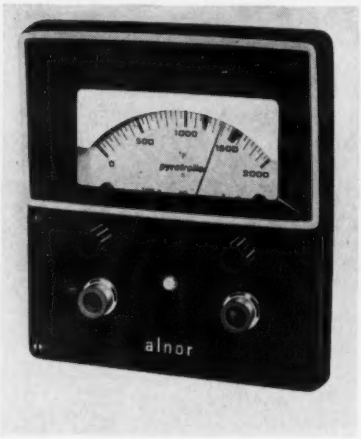
Equipment news

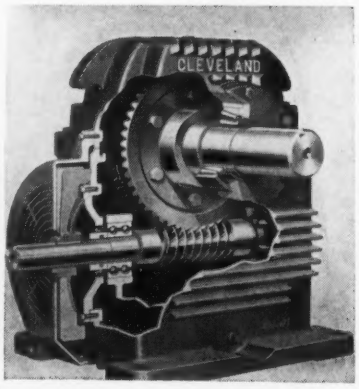
Begins on page 116



Double-target control indicates temperature

24 • Electronic on-off controller gives second control point for secondary or additional action. Besides controlling temperature, pyrometer can independently open or close a valve or turn a motor or blower on and off. Ranges: from 0 to 400 to 0 to 3000 F. Environmental-test-chamber range is −100 to +200 F. —Alnor Instrument Company

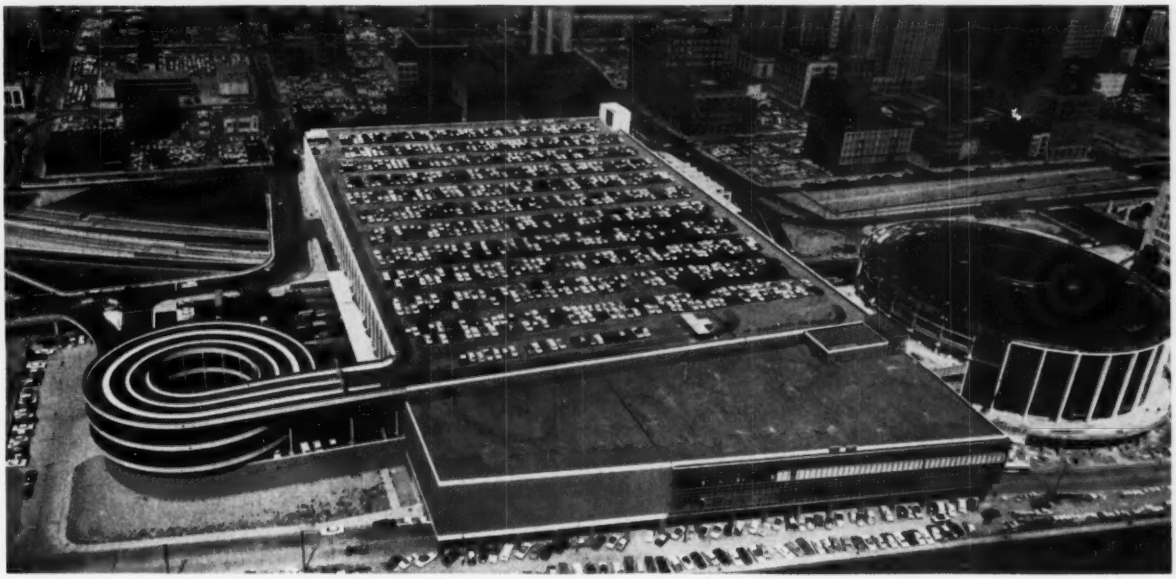
Just circle key numbers on the Reader Service card, page 103, to get complete product story



Worm-gear speed reducers feature high capacities

21 • Line is available in nine sizes ranging between 3- and 12-in. center distances. Ratios: from about 4:1 to 95:1, ratings: from fractional to

WHAT A HALL!



This is Cobo Hall, Detroit's new exhibition building—one of the largest of its kind in the world. The structure is three stories high and has 51 acres of floor space. Inside, there are 32 meeting rooms, a cafeteria, a coffee shop, a banquet hall that doubles as a ballroom and four huge exhibition areas—one area has about 300,000 square feet of exhibit space. ☐ The Hall is so big that they used 330 tons of USS NATIONAL butt-welded and seamless pipe in sizes ½" through 24" O.D. just for the heating and air conditioning systems. They run steam through the heating system at 300°F. and 35 psi. The air conditioning (system) can carry 10,000 gallons of water a minute at 65 psi. ☐ When you need quality pipe and tubes for power, heating and air conditioning installations—order USS NATIONAL. For information or technical assistance, write National Tube Division, United States Steel, 525 William Penn Place, Pittsburgh 30, Pa.

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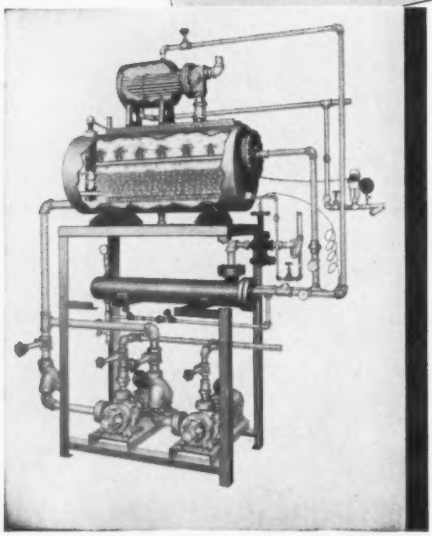
THE PRESIDENT

—continuous boiler feed water deaeration under .005 cc/liter without vent loss or adjustment, over a 10-to-1 load swing without sodium sulphite

R F Schaub



Day-in-day-out under boiler load swings as great as 10-to-1—**not** just under favorable fixed test conditions.

Excellent thermal efficiency (insignificant steam vent loss) under **all** regular operating conditions – with no vent adjustment for any load change.

No need for sodium sulphite or other additives. (If you need 'em, you just aren't getting full mechanical deaeration).

Plus at least 6 other savings in operations, maintenance and installation.

All are the result of the unique, but 15-year proved, Schaub design for external superheating, explosive flashdown and fully-vented operation.

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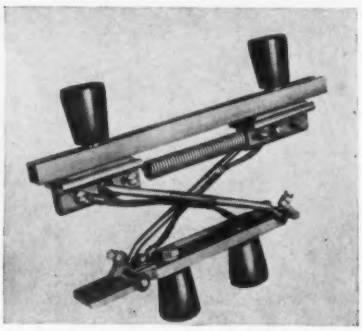
Name_____

Equipment news

Begins on page 116

175 hp. Reducer has extremely light, specially constructed radial fan which rotates in either direction. It's made of either plastic or aluminum. Fan mounts on input side of worm shaft to scour reducer's finned outer wall. —Cleveland Worm & Gear Div of Eaton Mfg Co



Medium-capacity current collector

25 • System handles load-current requirements not needing high-capacity integrated systems. Use for all types of ac and dc collection—traveling cranes, materials-handling units.

System has insulators, hangers, conductors, collectors integrated as a package. It's ready for mounting on a building wall.—H K Porter Company, Inc

Just circle key numbers on the Reader Service card, page 103, to get complete product story

Snubber tube fitting filters, gives dampening effect

32 • Fitting prevents sudden flow surges from damaging costly equipment, maker says. It will protect gages and other instruments from effects of pulsating pressure. You can use it to filter liquids and gases, especially in low-flow lines—pressure-gage lines, for example. Snubber is readily available for maintenance or replacement. —Crawford Fitting Company

continued

ANOTHER ACHIEVEMENT IN MODERN FLOW CONTROL BY CRANE

CRANE PRESSURE-SEAL BONNET GATE VALVES

are built to meet the toughest demands of high pressure/temperature steam and power piping systems. Special metals—silver, stainless steel, chrome and Stellite* guard all critical valve areas:

1 chrome-plated retaining ring remains freeze-free for easy dismantling; 2 precision tapered silver-plated seal ring eliminates bonnet joint leakage; 3 stainless steel inlay in body insures tight sealing, maximum protection against corrosion; 4 Stellite-faced seating surface and seat rings are engineered for trouble-free, minimum-maintenance service.

Crane Pressure-Seal Bonnet Gate Valves are armored with special metals and careful engineering details. Full travel disc guiding prevents wear and drag on seating surfaces. Flexible wedge disc won't stick even when the valve is closed hot and opened cold. Valve yoke is mounted to the body, transmitting operating torque directly to the valve. The smooth flowing contour design allows straight-through flow with no turbulence.

These gates are your best bet for long, safe, dependable service.

Sizes 1" to 24"; 600-, 900-, 1500- and 2500-pound classes

*Stellite is a registered trademark of Union Carbide Corp.

All Crane Pressure-Seal Bonnet Valves are ASA-rated. Minimum metal thicknesses comply fully with the requirements of ASA B16.5–1957, the ASA Code for Pressure Piping and the ASME Boiler and Pressure Vessel Code.

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For more facts circle 278 on Reader Service card, p 103

What makes the first gear-type coupling still first choice?

Check design . . . and you'll find Fast's Couplings (the original gear-type couplings) are superbly engineered, ruggedly built, smoothly running units designed to outlast the machines they connect.

Check completeness of line . . . and you'll find Fast's Couplings come in a complete range of sizes and types for shafts from ½" to 32" and larger.

Check service . . . and you'll find Fast's Couplings are backed by expert help from experienced field engineers . . . while outstanding stock facilities throughout the country insure speedy delivery of your coupling orders.

Check popularity . . . and you'll find Fast's Couplings are the choice of more industrial equipment manufacturers than any other shaft coupling.

Check Fast's for your coupling needs today.

KOPPERS COMPANY, INC., 1104 Scott St., Baltimore 3, Md.

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Equipment news

Begins on page 116

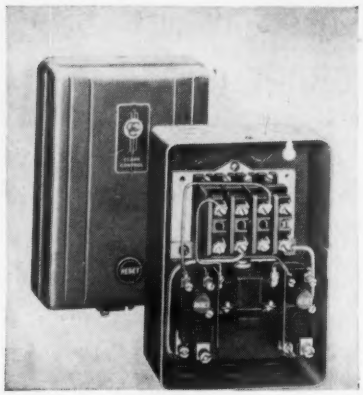
Portable 110-v-ac power

20 • Electronic development makes 110-v-ac power possible from 12-v storage battery. Use to operate electric hand tools, regular electric-light bulbs, anything that does not exceed unit's wattage output. Comes in four models from 150- to 500-w output.—The Electric Storage Battery Co

Gas analyzer

61 • Thermal-conductivity gage detects percentage of hydrogen in gas and changes in natural-gas composition requiring immediate readjustment of gas burners. Gage is available with contact-meter relay control units which sound the alarm or protect system from gas change. Thermal-conductivity cell withstands vibration and overpressure to 3000 psig. Price: $265.—Hastings-Raydist, Inc

Just circle key numbers on the Reader Service card, page 103, to get complete product story

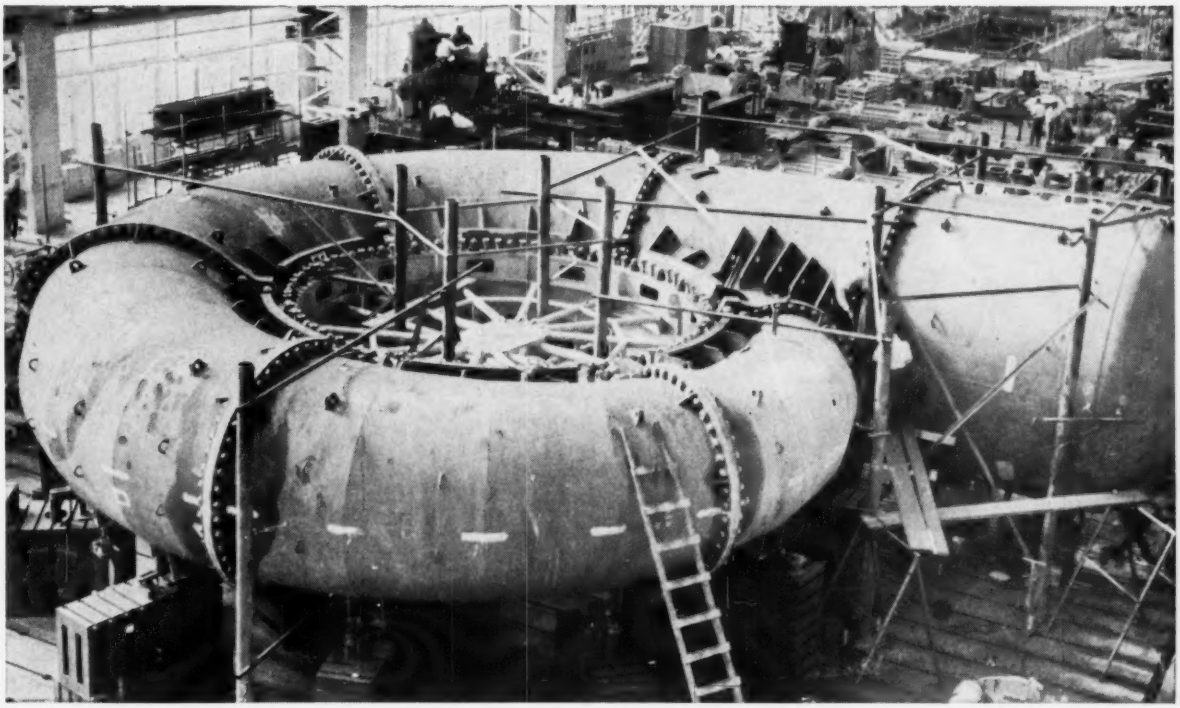


Motor starters, contactors are nonreversing

36 • Starters and contactors are designed for full-voltage starting of 1/6- to 2-hp squirrel-cage motors. You can use same unit on either single- or 3-phase motors operating on 110 to 600 v and 25 to 60 c. Enclo-

HITACHI

now completing the first hydraulic turbines for Thailand's Yanhee Project



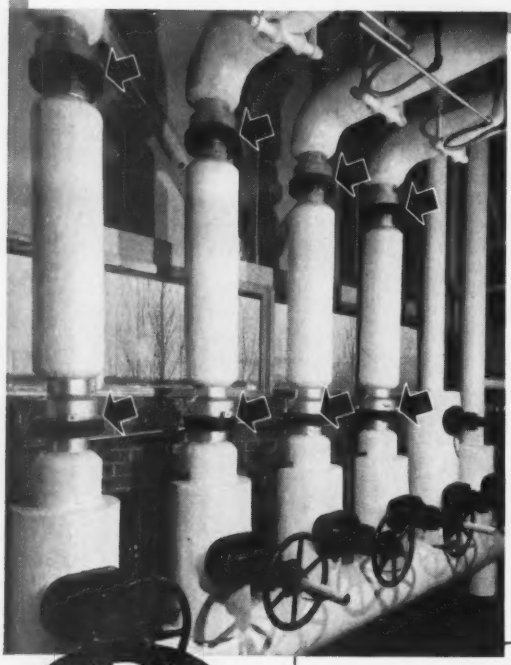
Shop tests were recently completed on the spiral casing for the first of two 115,000 HP Francis-type turbines being completed by Hitachi for Thailand's Royal Irrigation Department. These will be the first of the planned 8 sets of generating units to be installed at the downstream of the Bhumiphol Dam, as part of the Yanhee Multipurpose Project which will commence operation in 1963 and eventually supply 560,000 kW of power to Bangkok and Thonburi. The vertical shaft Francis turbines have been designed to deliver 115,000 HP under the effective head of 112 m and for a speed of 150 rpm. Their spiral casings, with inlet diameter of 4150mm, will each be divided into 7 sections for transportation by barge up the Ping River to the site.

Hitachi, Ltd.
Tokyo, Japan

Cable Address: "HITACHY" TOKYO

For more facts circle 282 on Reader Service card, p 103

Barco Solves Valve Piping Expansion Problem



Relieves Strain on Valves

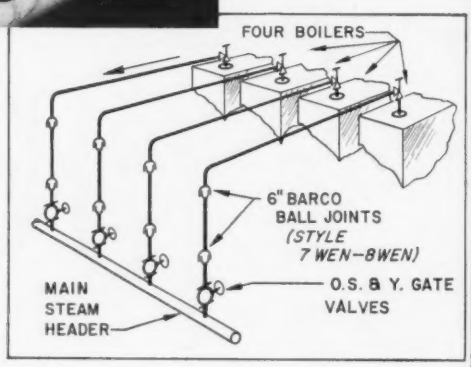
This photograph shows an interesting new installation of eight Barco Flexible Ball Joints (see arrows) on four 250 psi boiler steam lines in a West Coast industrial plant. The schematic diagram (below) shows the piping layout.

Due to the fact that operation of individual boilers is intermittent, complicated expansion, contraction, and torsional movements occur in the piping. All of these movements are easily accommodated with the aid of the Barco Joints, relieving reactive forces on the valves.

BARCO

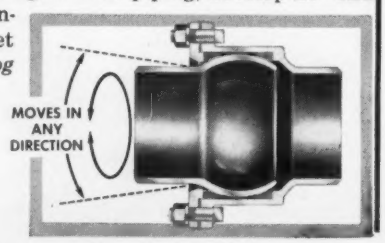
BALL JOINTS

1. Handle Expansion
2. Relieve Torsion
3. No "End Thrust"



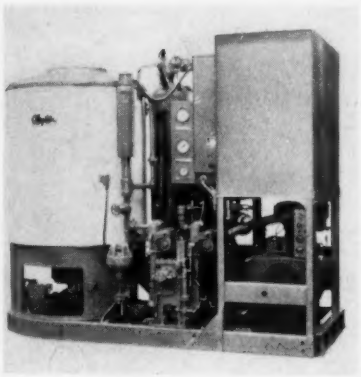
PROBLEM—Originally, in the plant shown above, it was thought that the "spring" in the long runs of piping would take care of *thermal expansion* and *torsional stresses*. SUCH WAS NOT THE CASE. Serious trouble was encountered, tending to crack valve flanges and twisting so they would not seat tight.

ANSWER—Barco Ball Joints solved the problem, LOGICALLY, SIMPLY, ECONOMICALLY. These rugged all-steel joints have no thin wall sections, no critical points of fatigue, no rubber seals. They are practically indestructible. They provide points of flexibility in piping. Easy to engineer. They fit right in the piping; develop no "end thrust"; require no expensive anchoring. Sizes and styles to meet your requirements. *Send for catalog and information.*



BARCO MANUFACTURING CO.
522E Hough Street, Barrington, Illinois
In Canada: The Holden Co., Ltd., Montreal

sures are available for separate pushbutton operation, "hand-off-automatic" selector switch or with start-stop pushbutton.—The Clark Controller Company



Steam generator is self-contained

60 • Automatic, portable steam generator provides own electrical supply, needs only fuel and water. Oil-fired unit operates on forced-circulation principle, providing full steam pressure in about three minutes. 200-psi generator contains own gasoline-engine drive to operate electrical controls.—Clayton Manufacturing Co

Just circle key numbers on the Reader Service card, page 103, to get complete product story

Voltage comparator insensitive to frequency

63 • Voltage comparator keeps regulator informed regardless of frequency. Using bridge circuit of zener diodes and resistors with magnetic amplifiers, it is effective for hydroelectric installations where water-control valves cannot close quickly enough to compensate for turbine overspeeding. Circuit dissipates minimum amount of heat and imposes lower burdens on transformers.—Allis-Chalmers Mfg Company

HEAT EXCHANGERS—ATOMIC REACTORS—CHEMICAL PROCESSING EQUIPMENT

Safe, efficient cleaning of stainless steel boilers, heat exchangers, atomic reactors, chemical processing equipment! It's assured, when chloride-free Pfizer Citric Acid is used by your chemical cleaning service company. Easier and more efficient after-rinsing is another definite plus! Check for yourself these unique advantages of using Pfizer Citric Acid:

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3. Citric acid cleaning completely eliminates the possibility of chloride stress corrosion.
4. Citric acid can be effectively inhibited without losing its cleaning or sequestering ability.
5. Citric acid is sold as a dry, 100% acid—meaning savings in storage and handling.
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For more facts circle 284 on Reader Service card, p 103

ONE OF A SERIES OF CHATS ABOUT CONSERVATION AND CONTROL OF HEAT

SARCO TOPICS

MODERNIZING A STEAM SYSTEM MEANS TRAPPING, TOO

Take an older building that has generated its own steam for decades and let's say it's switching to district steam. How can it take advantage of switch-over to rid itself of those classic symptoms of antiquated systems: trap maintenance at overtime rates, water-hammer, and live steam loss?

Well it just so happens a 17-story office building at 635 Madison Avenue, New York, recently did just that. Its steam system was overhauled; but recovery is now complete and it didn't hurt a bit.

First, let's look at the system as it was: Maintenance of the old system had to be done at overtime rates in off hours, because the system could not be shut down during business hours. There were frequent breakdowns. Passage of live steam into return lines when traps failed open not only wasted energy but caused water hammer, and when traps failed closed, water accumulated in steam supply mains and equipment.

The reason we give you this dreary picture is that it's so typical of old systems, and so easily fixed. The building management simply replaced bucket and float traps with Sarco Thermo-Dynamic Steam Traps, Type TD-50, matched and correctly sized to the application. And at the risk of sounding like a TV commercial, results were immediate: maintenance practically

zero, no water hammer, no loss of live steam, engine room crew free for other jobs. And, need we add, considerable savings.

We find it difficult to be modest about the TD-50 because it comes so close to being a cure-all. The facts are these: It has only one moving part, a stainless steel disc; it shuts off *positively*, so no steam can be lost; it discharges condensate as rapidly as it is formed; its pressure range of 10-600 psi makes it possible to standardize on one steam trap for a variety of applications that formerly required traps of many types and ratings.

Funny thing is, the TD-50 is so dog-gone *simple* and *small*, people find it hard to believe it does what it does. At 635 Madison Avenue, for example, changeover took only 30 minutes per trap, and trapping was accomplished with a few pounds and cubic inches of traps where hundreds of bulky pounds were needed before to do the job.

Write us for details, won't you? You've nothing to lose but your troubles, your waterhammer, and your worries.

HEATING COILS CAN CATCH COLD

Let's face it: even the best "non-freeze" air heating coils may freeze if they handle incoming air even slightly under 32°F. and aren't drained properly. Let's face it again: It's *not* inadequate steam trapping capacity that's most usually to blame. We don't mean to belabor the point, but if trap inlet pressure falls lower than trap outlet pressure, condensate *is* going to collect in the coil. And it's *bound* to freeze below 32°F. Take a preheat coil designed to heat air from 0°F. to 50°F. using steam at a maximum pressure of 10 psig. As the outside air temperature rises above 0°F. heat demand decreases, the temperature controller reduces the steam pressure to compensate for reduced heat demand, and you're ripe for ice cubes in your coil tubes.

At Sarco we firmly believe that practical help is much more useful than sympathy noises. We can tell you (if it happens to be *you* who are caught with your temperature down) of at least three cures for fatal drop in pressure differential. They're quite simple and we would show not the slightest hesitation about revealing them to you.

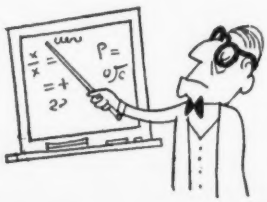
In fact, we'd also like to send you a master chart that enables you to check at a glance the danger point in handling outside air—an extremely useful piece of information—and a bulletin on Float-thermostatic steam traps.

It may hasten matters if, when you request this bundle of facts, you refer to the literature as Sarco Technical Bulletin No. T503.

MORE THAN ONE WAY TO TRAP STEAM

Just as there's no universal trapping application, there's no universal steam trap. The fact is that there are five basic steam traps in use today—and they're all rather thoroughly described in a rare monograph by Sarco engineers titled modestly and succinctly enough: Lecture 1A. You, personally, may not need a copy of this fundamental document, but wouldn't you like to know that your own people were up to date on steam trap basics?

It's easy to be sure this vital information gets into their hands: simply request a quantity of Lecture 1A and distribute copies as needed, with a little subtle persuasion that they be read. We can even arrange for a personal slide film lecture, followed by authoritative answers to trapping questions, if you can get an in-plant group together.



In any event, write to us. You may discover that a lot of progress is being made that isn't concerned with getting men to the moon.

Pardon our monopolizing the conversation in this series of paid communiques, but we're trying our best to interest you in certain subjects that concern us both—to the point where you'll communicate. 5108

SARCO

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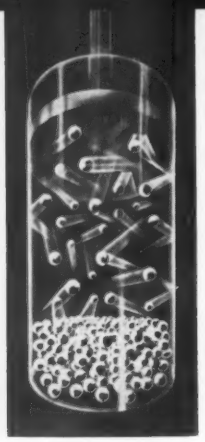
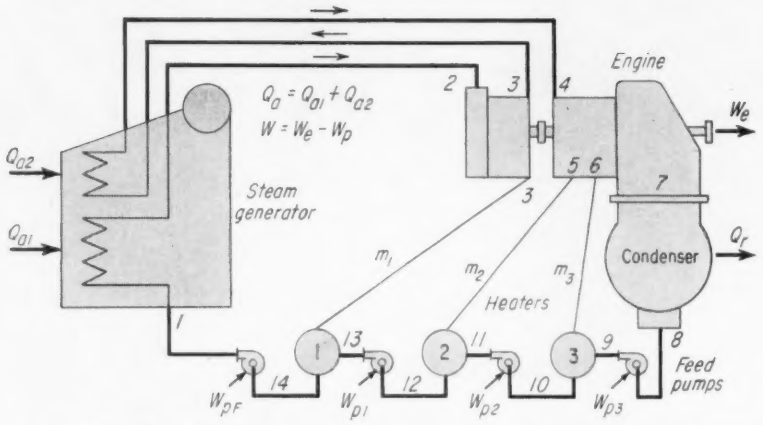
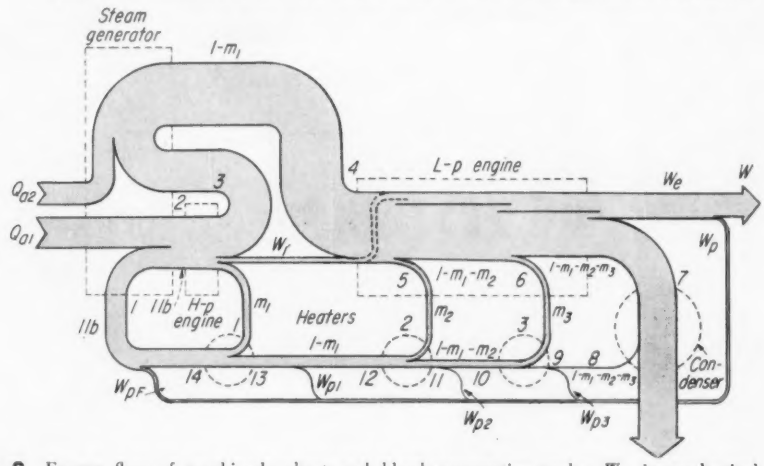
For more facts circle 286 on Reader Service card, p 103





1 Combined reheat and bleed-regenerative cycle makes use of economy features of each cycle type. Reheated-steam flow is less than the flow through initial superheater



2 Energy flow of combined reheat and bleed-regenerative cycle: W_1 is mechanical output of first engine section flowing through shaft while steam goes for reheating

By B G A SKROTZKI, Associate Editor

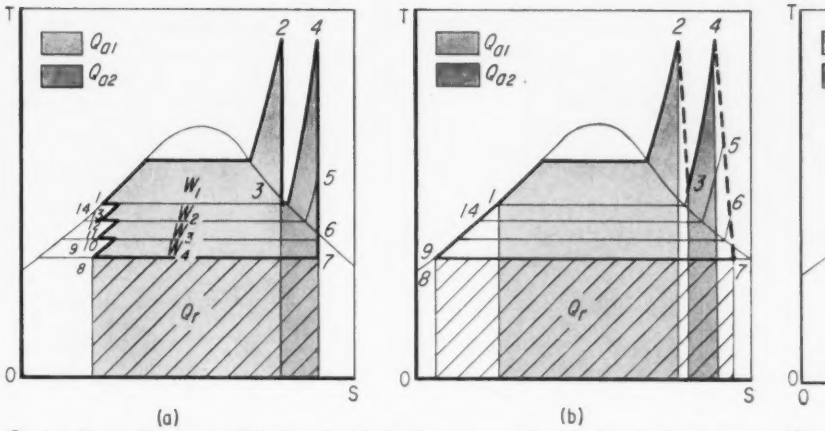
Rising cost of fuel and increasing demand for shaft energy spur the continuous quest for high-efficiency plants. One route to better thermal performance:

Combined heat-power cycles

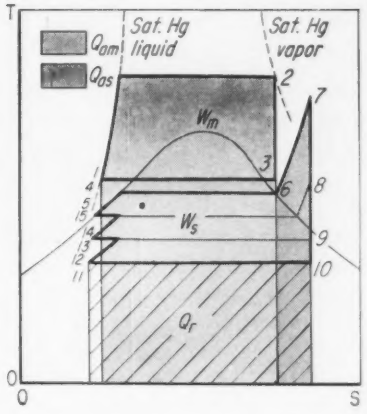
Basic bag of tricks the energy-systems engineer can use to achieve high-economy power generation was opened in previous parts of this series. These methods center on adding all heat input to a cycle at the highest average temperature possible and rejecting the unavailable energy at the lowest average temperature. No other fundamental methods have been proposed outside of direct electric-energy generation now being researched so vigorously.

Combinations. But the ingenuity of our plant designers under the pressure of rising fuel costs has not let them rest with the basic cycles. They have found that by combining these basics they can raise overall plant thermal efficiency without too much complication. We'll look at these combinations: (1) reheat-regenerative cycle (2) mercury-steam cycle and (3) gas-turbine steam-turbine cycle.

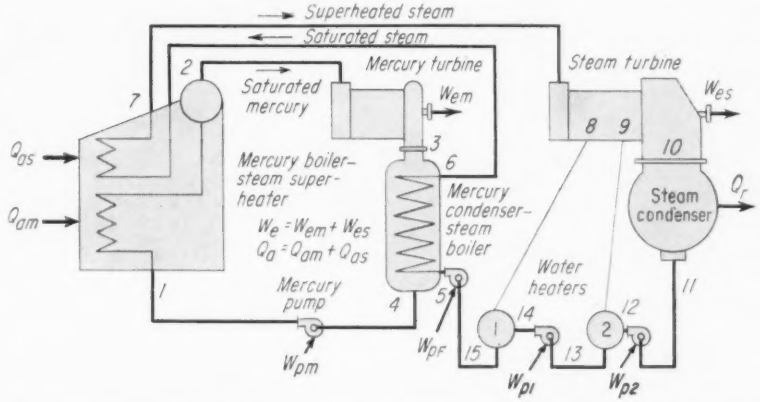
Reheat-regenerative cycle, Fig. 1, uses both bleed heaters for feedwater heating and one or more stages of reheating. For cycle analysis in Fig. 1 we divide the heat input into two parts, Q_{a1} and Q_{a2}. The first



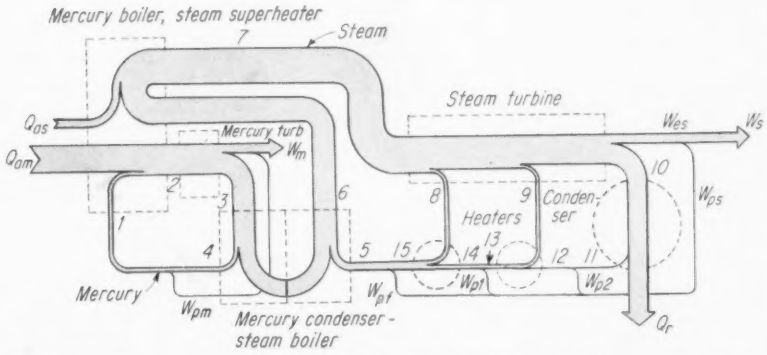
3 (a) Proportionate-area T-S chart for ideal reheat-regenerative-bleed cycle shows separate heat inputs. (b) These are actual state points for cycle with irreversible engine



6 Combined T-S chart for Hg-steam cycle shows constant-temperature heat input



4 Mercury-steam cycle has two separate heat inputs from common furnace and two separate engines, a mercury turbine and a steam turbine, but only one heat rejection



5 Energy flow of mercury-steam cycle: here the heat rejected by mercury cycle is part of heat input to steam cycle with additional heating Q_{as} from common furnace

evaporates and superheats the full feedwater flow entering the boiler and steam generator. Superheated steam flows through the first part of the engine (turbine), part of the steam going to feedwater heater 1 and the remainder back to the reheater to receive the heat input Q_{a2}.

Reheated steam then enters the second part of the engine to bleed off to the heaters at *5* and *6*. Remainder exhausts to the condenser. Condensate returns to the steam generator joined on the way by the bleed condensate in the heaters to start the whole cycle over again at point *1*.

Fig. 2 shows the energy flow through this cycle. It can be cross referred to Fig. 1. Note that work output W_1 of the first part of the engine (h-p engine) flows along the shaft while steam with diminished energy returns to be resuperheated in the steam-generator reheater.

Fig. 3*a* shows proportionate-area T-S chart for an ideal cycle. Regenerative heating of the feedwater diminishes the amount of Q_{a1} by raising the feedwater temperature to the boiler and so boosting average temperature of heat addition to increase the overall availability of the energy input. Q_{a2} input for reheating also raises average temperature of the total input for an overall gain in cycle efficiency.

Fig. 3*b* shows an actual-state-point T-S chart of an actual combined cycle with irreversible engine expansion of the steam. Inherent high efficiency of the cycle offsets the deteriorating effect of irreversible expansion processes. As usual, the net areas on an actual-cycle chart do not measure the net work produced.

Despite the relative complexity of this cycle its thermal efficiency can be figured easily as:

$$e = \frac{W}{Q_a} = \frac{Q_a - Q_r}{Q_a}$$

$$= 1 - \frac{Q_r}{Q_{a1} + Q_{a2}}$$

Based on 1 lb working fluid entering

the boiler and turbine throttle we can write for each of the terms from Fig. 3*b*:

$$Q_r=(1-m_1-m_2-m_3)\ (H_7-H_8)$$
$$Q_{a1}=(H_2-H_1)$$
$$Q_{a2}=(1-m_1)\ (H_4-H_3)$$

The bleed flow terms m will have to be calculated by a First Law energy balance about each of the heaters, as we did for the regenerative cycle in Part 47 last month.

Steam rate of the cycle refers to the lb of steam entering the turbine inlet per unit of cycle output. For example:

$$SR=\frac{3413}{W}=\frac{3413}{Q_{a1}+Q_{a2}-Q_r}$$

This gives us the steam rate in lb per kwhr (=3413 Btu).

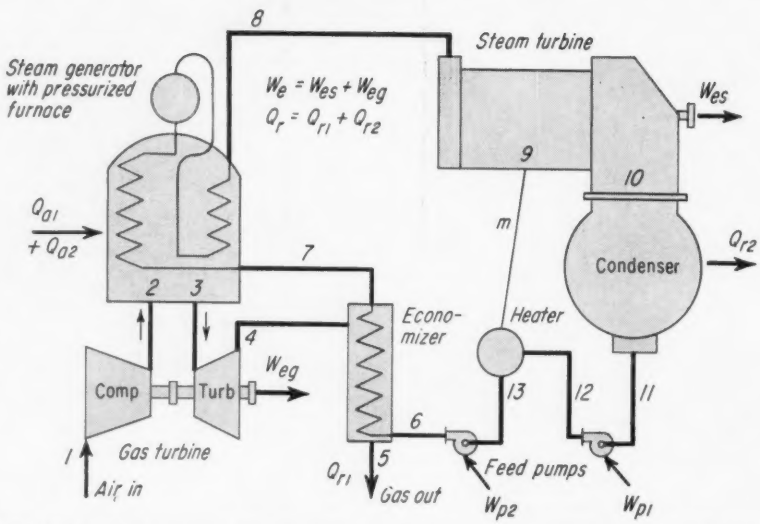
Cycle heat rate is simply:

$$HR=\frac{3413}{e}\qquad \text{Btu per kwhr}$$

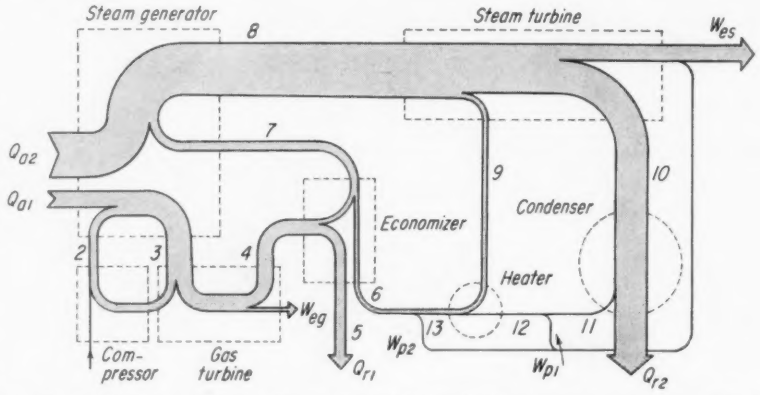
Mercury-steam cycle, Fig. 4, has a common furnace to supply heat energy to two separate fluid circuits in the mercury-boiler steam-superheater unit. Heat input Q_{am} vaporizes liquid mercury entering the unit at *1*. The saturated mercury vapor enters the mercury turbine to generate shaft energy W_{em}. The wet vapor exhausts to the mercury-condenser steam-boiler unit which it leaves as a saturated mercury liquid to be pumped back to the mercury boiler. Mercury part of the plant works as a simple Rankine cycle at relatively high temperature levels.

Energy rejected by the mercury cycle is part of heat input to the steam cycle which the mercury cycle "tops". Water enters the mercury-condenser steam-boiler unit as a compressed liquid at *5* to be evaporated to a saturated vapor at *6*. It then goes to the steam superheater to receive Q_{as}, enters the steam turbine to generate shaft work W_{es}. Exhausting to the condenser at *10* to reject Q_r, the saturated liquid leaves at *11* to flow through the feedwater heaters and repeat the cycle from point *5*. Fig. 5 shows the energy flow of this binary-vapor cycle with two points of energy addition and one point of rejection, but two points of shaft work output.

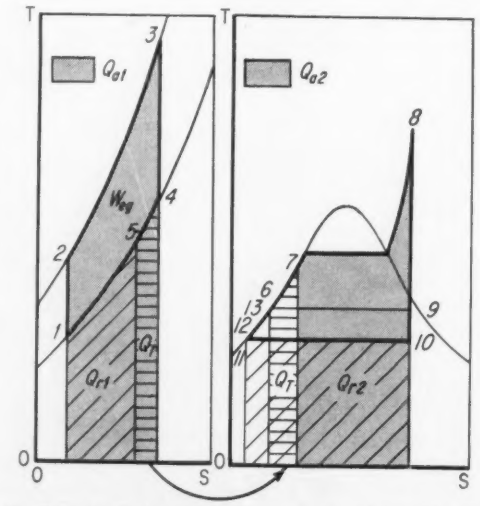
Fig. 6 is a combined T-S chart of the mercury-steam cycle. The part for



7 Combined gas-turbine steam-turbine cycle has common gas-turbine-cycle combustor and steam-generator furnace. Economizer salvages some heat rejected by gas turbine



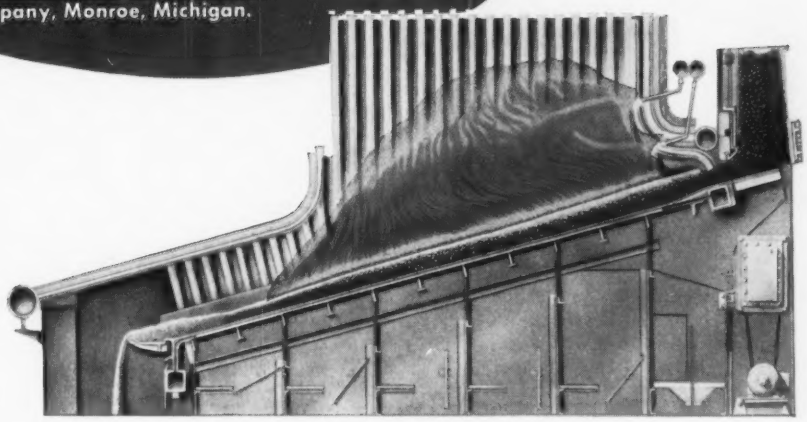
8 Energy-flow chart of gas-turbine steam-turbine cycle shows two separate engines and two separate heat rejections from plant. Pressurized furnace is feature of cycle



9 T-S charts for gas-turbine steam-turbine cycle: irreversible heat transfer of Q_T from gas-turbine exhaust to feedwater of steam-turbine cycle shrinks Q_{a2}

now it's DETROIT VIBRA-GRATE STOKER *and* DETROIT-TAYLOR STOKER

Vibra-Grate and Taylor Multiple Retort Stokers formerly manufactured by American Engineering Company of Philadelphia are *now* and will *continue to be* manufactured, sold and serviced by Detroit Stoker Company, Monroe, Michigan.



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5 CHESTERTON PACKINGS expressly developed for STEAM

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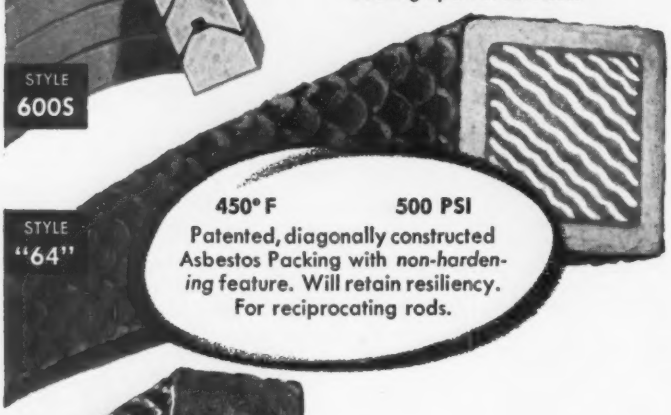
Improved self-sealing moulded Asbestos Packing with multiple feather sealing lips. All services.



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Thermo refresher

Begins on page 130

mercury refers to 10 lb of mercury while that for steam refers to 1 lb of water. Chart shows the advantage of the binary-vapor idea. In vaporizing mercury at 940 F, saturation pressure is only about 125 psia, minimizing weight of equipment needed. Mercury lets the cycle take in most of its heat at a constant high temperature. It rejects heat at a high temperature, too, 475 F at 1.3 psia pressure, and this is absorbed by the steam cycle at about 430 F and 350 psia. Separate steam superheating helps raise overall efficiency of the cycle by absorbing heat otherwise wasted.

Several mercury-steam-cycle plants are running in the U.S., but the vast improvement in performance of high-pressure high-temperature reheat regenerative cycles now used makes it unlikely that more binary-vapor plants will be built in the future.

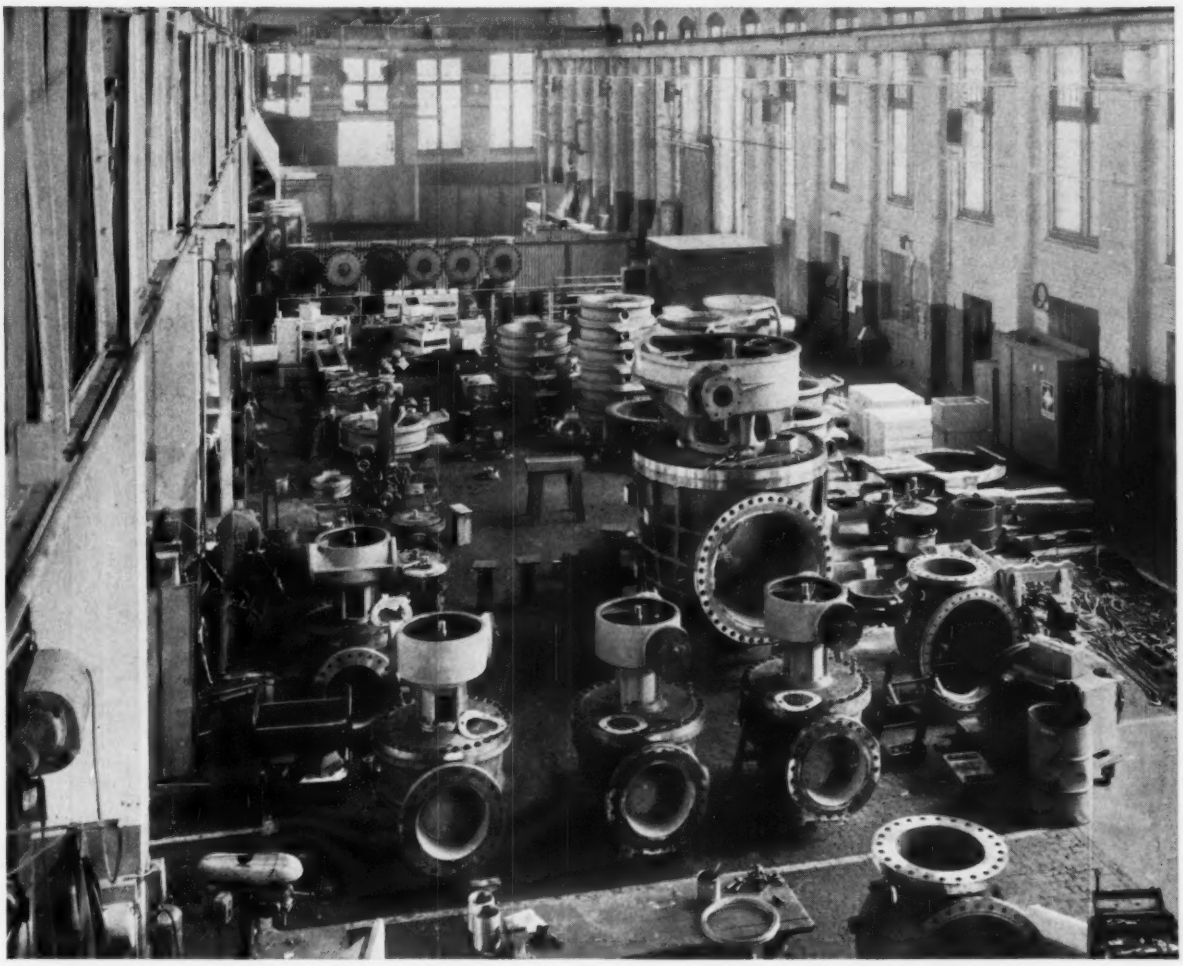
Gas-steam-turbine cycle, Fig. 7, is newly being applied in the U.S.—several plants are now running. The two types of cycles can be combined in a variety of ways; Fig. 7 shows only one of them. Here air enters a compressor at *1* to be pressurized for delivery to a steam generator's pressurized furnace at *2*. Fuel burned in the furnace furnishes Q_{a1} for the gas to the gas turbine at *3* and also Q_{a2} for evaporating and superheating steam for the steam cycle at *8*.

Hot gas leaves the furnace at *3* to pass through the gas turbine and generate shaft output W_{eg}. Exhaust gas then leaves at *4* to flow through the economizer, giving up part of its heat to the feedwater, and then leaves at *5* to atmosphere to carry out rejected heat Q_{r1}.

Feedwater in the steam cycle enters the economizer at *6* to be preheated at *7* before entering the steam generator where it absorbs input Q_{a2}. The steam and its condensate flow through a normal regenerative-bleed cycle to produce shaft output W_{es} and reject heat Q_{r2}, returning heated feedwater to point *6*.

Fig. 8 shows the energy-flow diagram for the gas-steam-turbine cycle. This features two heat additions, two

ALLIS-CHALMERS



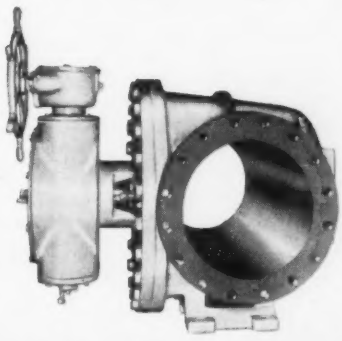
Another shipment of "habit-forming" valves

built for performance that always captures repeat customers!

Here we see one small part of the latest shipment of Allis-Chalmers valves destined for a long-time customer. These units will augment hundreds of A-C valves already installed in the same western metropolitan water system, many of them tracing satisfactory service back a quarter of a century!

Shown are four 300-lb, 24-in. *Rotovalve* units (two motor-operated, two manual) . . . a 48-in. cast-steel *Rotovalve* for 300 psi (motor-operated) . . . and several butterfly valves of the 136 ordered (all rubber-seated, motor-operated, ranging in size from 12 to 48 inches).

Allis-Chalmers offers today's only complete, perpetual rotary-valve stocking program, assuring you fastest delivery, thanks to "off-the-shelf" availability. For help anytime, contact your nearby A-C valve representative, district office, or simply write to **Allis-Chalmers,** *Hydraulic Division, York, Pa.* A-1395



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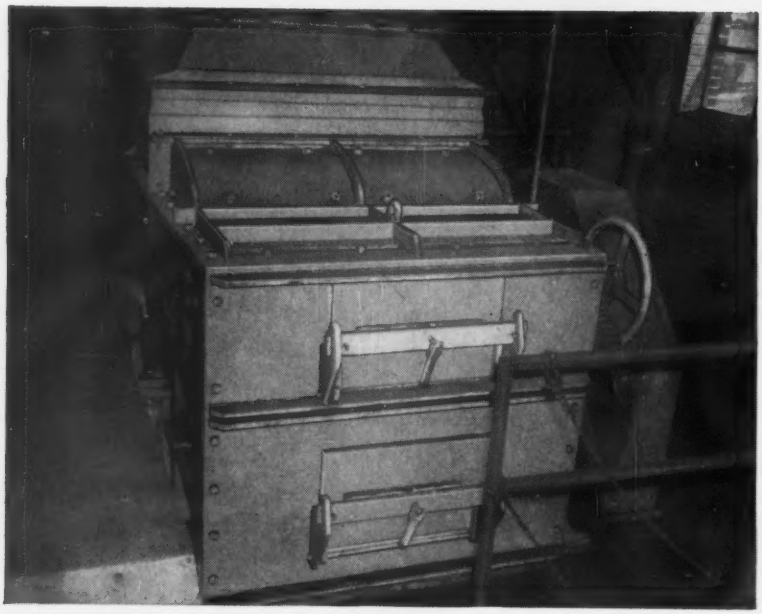
CRUSHING FACTS

from *American* PULVERIZER CO.



USER REPORT

"NO PARTS REPLACED IN 6 YEARS OF SERVICE"

The operation record at this municipal power station again proves the stamina and trouble-free performance of American AC Rolling Ring Crushers.

Although reducing ROM coal (up to 6" size) to ¾" this crusher has never needed a part replacement. Over 334,000 tons of coal have been reduced since installation.

The double life of the American-originated rolling shredder ring brought further economy. The rings, which split coal instead of crushing it, are reversible. After four years the rings were reversed to put the unused edges to work. This adds more years to their operational life.

Since 1908, American Pulverizer has manufactured reduction equipment exclusively. Every crusher is custom-built to meet your requirements and ruggedly constructed to give you the lowest possible cost per ton of coal reduced.

Our Engineering Department will help you with your reduction problem and recommend the proper equipment.

Complete Literature Available. State your tonnage requirements.

5012

American PULVERIZER COMPANY

ORIGINATORS AND MANUFACTURERS OF RING CRUSHERS AND PULVERIZERS

1349 MACKLIND AVE. ST. LOUIS 10, MISSOURI

shaft-work outputs and two heat rejections. Part of the heat rejected by the gas turbine is waste-heat-recovery input to the steam cycle.

Fig. 9 is a pair of T-S charts showing the individual gas and steam cycles and how they are tied through heat transferred in the economizer Q_T. This assumes an irreversible transfer of this heat from the gas to the water. Chart is drawn for 2.6 lb of gas and 1 lb of water.

Thermal efficiency of this combined cycle may be figured as:

$$e = \frac{W}{Q_a} = \frac{Q_a - Q_r}{Q_a}$$

$$= 1 - \frac{Q_{r1} + Q_{r2}}{Q_{a1} + Q_{a2}}$$

Relative weight of gas w_g to 1 lb of water must be figured by energy balance about the economizer:

$$H_7 - H_6 = w_g\,(H_4 - H_5)$$

Then the other factors for efficiency will figure as:

$$Q_{r1} = w_g(H_5 - H_1)$$

$$Q_{r2} = (1 - m)\,(H_{10} - H_{11})$$

$$Q_{a1} = w_g(H_3 - H_2)$$

$$Q_{a2} = H_8 - H_7$$

The bleed steam flow m must be calculated from an energy balance about the feedwater heater.

Steam rate for this cycle would have no meaning, since two different working fluids are involved. Heat rate for the cycle would simply be:

$$HR = \frac{3413}{e} \quad \text{Btu per kwhr}$$

Next month's part will cover steam flow through nozzles.

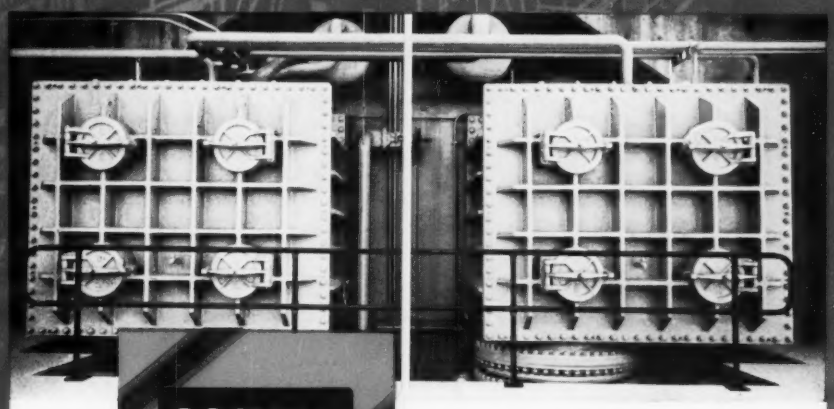
World's first 500-mw atomic-power plant is going up at Sizewell, England. Coming to full operation in 1966, it is expected to produce power at a lower cost than any other nuclear station under construction.

For more facts circle 290 on Reader Service card, p 103

circle 291 on Reader Service card, p 103 ➤

where trouble-free performance is a matter of pride...

FLORIDA POWER & LIGHT COMPANY
Lauderdale Plant



SCOVILL®

Typical condenser installation in the Lauderdale Plant employing approximately 352,000 linear feet of Scovill Aluminum Brass Heat Exchanger Tube, ⅞" O.D., 0.049" wall thickness.

HEAT EXCHANGER TUBE for Applications from Marine to Petrochemical, from Compressor Intercoolers to "Cat-Cracker" Exchangers, in these popular Alloys ...Phosphorized Admiralty • Admiralty • Arsenical Admiralty • Red Brass, 85% • Deoxidized Copper • Arsenical Copper • Cupro-Nickel, 10%-20%-30% • Aluminum Brass • Aluminum Bronze, 5% • Muntz Metal • Duplex Tube

HEAT EXCHANGER TUBE

The new Lauderdale Plant of the Florida Power & Light Company is the largest power producing unit in Florida. Its condensers are tubed with Scovill ALUMINUM BRASS Heat Exchanger Tube, selected to assure trouble-free performance under specific conditions at this important station.

Aluminum Brass is a Scovill alloy that has proved to be highly resistant to corrosion by salt and brackish waters and to the combined effects of corrosion and erosion in salt water service. These good qualities are due to the special nature of the thin, adherent, continuous and self-renewing film which develops on the surfaces of this alloy in service. It is being extensively used in marine and tidewater condenser installations.

Your own condenser and heat exchanger service conditions may be similar or they may be entirely different and perhaps better served by one of Scovill's eleven other popular Tube Alloys. Scovill Technical Service, considered by many the most experienced in the field, can help you make the right selection for trouble-free operation.

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SCOVILL MANUFACTURING COMPANY
Mill Products Division, 99 Mill Street, Waterbury, Connecticut. Phone PLaza 4-1171

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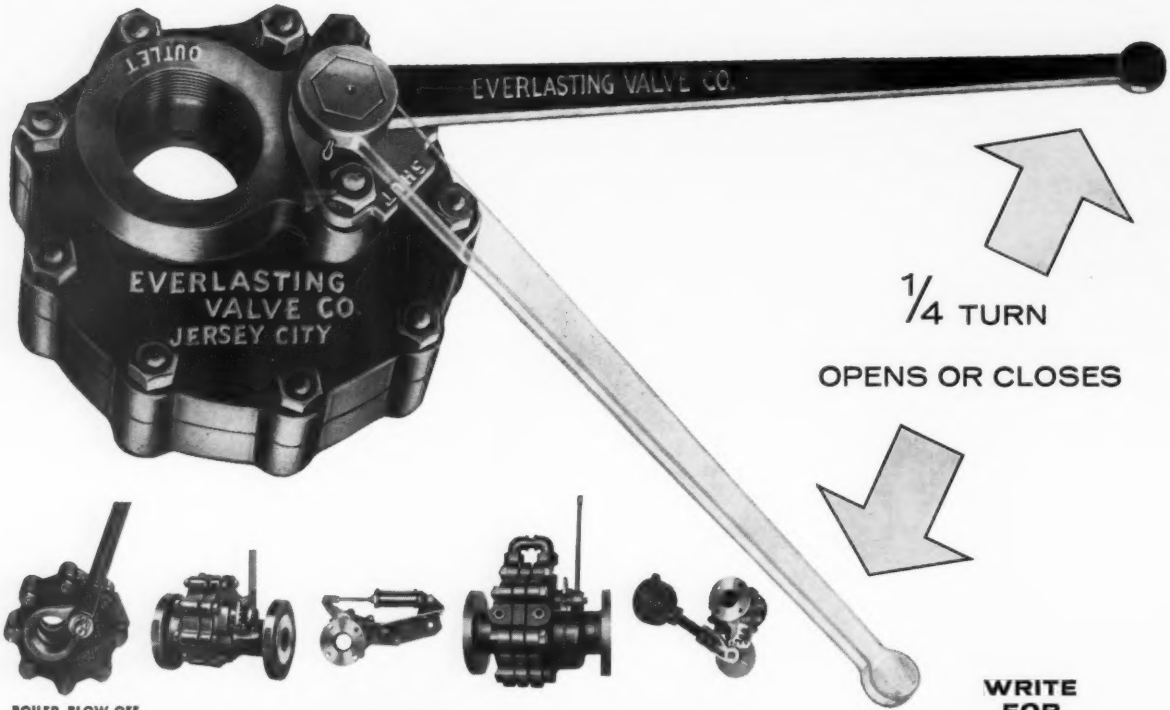

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EV-409

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THE ONLY NATION-WIDE SALT COMPANY
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For more facts circle 293 on Reader Service card, p 103

Marmy's Egyptian nightmare

Marmaduke and the local cop were working vigorously on the horse's stern end, trying to boost the animal into the cabaret

Pandemonium erupted at the swanky Taufiq Cabaret on Muhammed'-Ali Square in Alexandria, Egypt. It was in the wee hours of a Sunday morning when only the usual after-hours crowd was about—natives dressed in night-gown-like robes, the predatory fez-wearing "guides" who attached themselves to strangers like leeches, cab drivers cruising around for fares and early-morning revelers of various nationalities staggering along the quiet square.

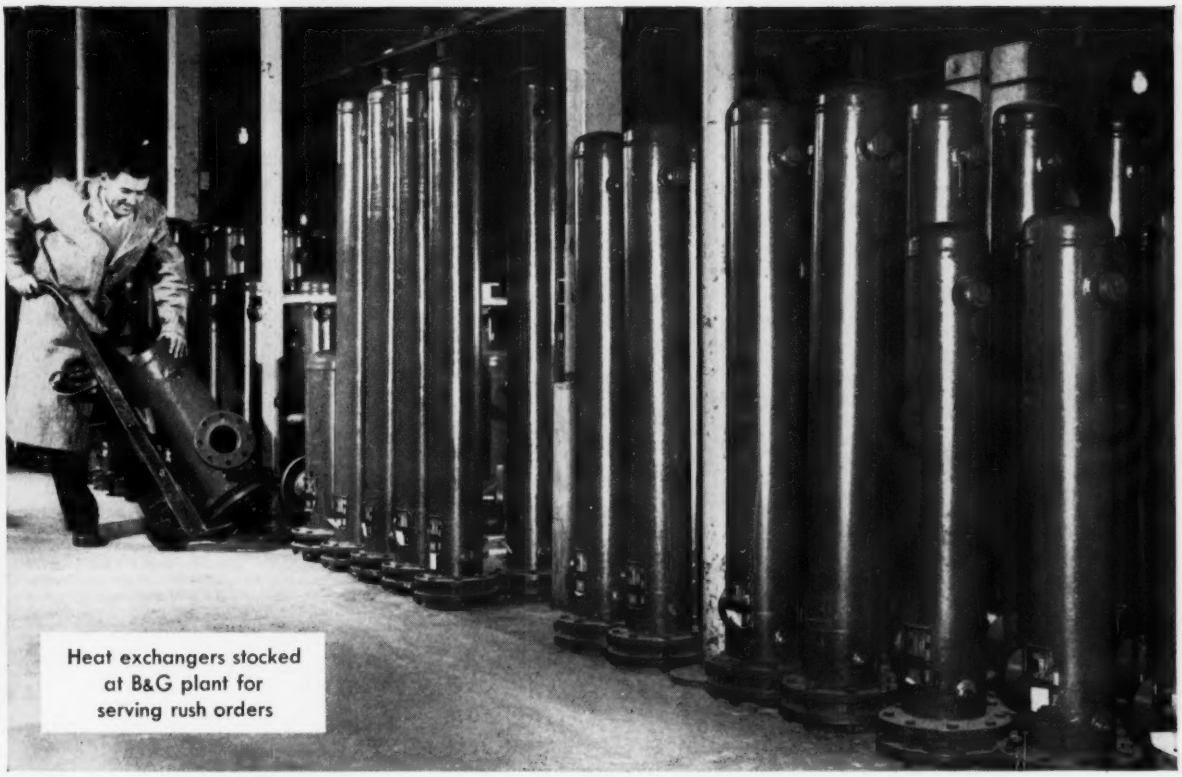
Suddenly, voices rang out in an excited staccato jumble in front of the Taufiq. Everyone within hearing distance raced towards the cabaret to investigate. Center of attraction was the stern end of a horse protruding from the doorway. A swarthy native policeman and a husky American had their shoulders to the horse's rump, working feverishly to push the balking animal inside. But the quadruped resisted stubbornly by bracing all fours firmly against their effort.

"Heave ho—NOW, all together—HEAVE," roared the American in his foghorn voice, putting all his hefty beef against the horse's port rump, while the dark-skinned policeman worked vigorously on the starboard side.

Yells of encouragement in a dozen tongues came from inside and outside the cabaret. But most of them urged the horse to victory. Suddenly a cab drove up to the curb and a hard-boiled weather-beaten mariner jumped out. He was Captain Roger Squid of the Greek contraband runner *El Dikka*. The captain and his ship were notorious in Mediterranean ports for handling hot cargo—anything from guns to immigrants to opium, long as a fast buck could be made.

"Well, if it isn't Marmaduke Surfaceblow—and up to his old tricks," hooted the surprised captain, busting out laughing. "What in hell you trying to do, Marmy, run an Egyptian horsepower experiment? Ha ha ha!"

The muscular American relaxed for a split second to identify this familiar voice. The horse seized his advantage and quickly backed out, pushing both his tormentors aside. As the horse's head cleared the doorway, a flood of



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NEED A HEAT EXCHANGER IN A HURRY?

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B&G Heat Exchangers are made in both U-bend and straight tube, floating tube sheet models. A comprehensive stock of U-bend exchangers is available for fast shipment. Refrigeration condensers, evaporators, liquid receivers and suction line heat exchangers are also maintained in factory stock.

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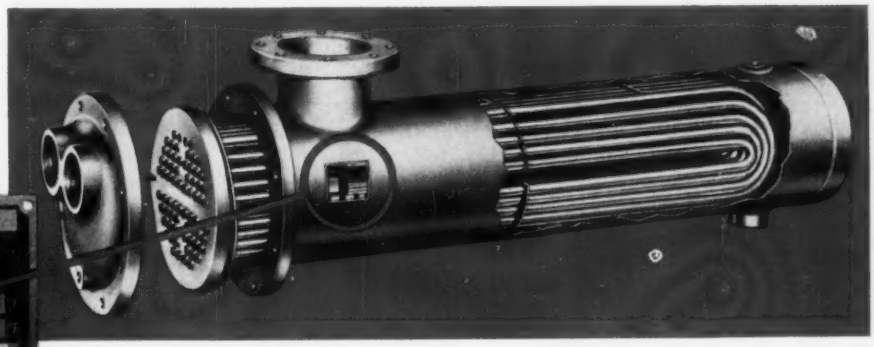

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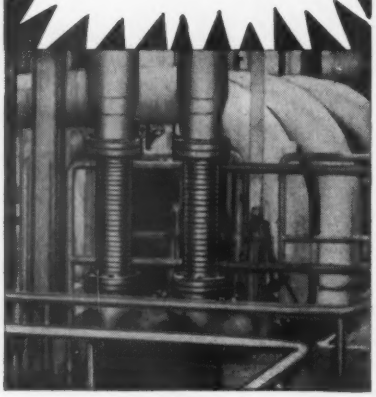

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Penflex

TIGHT AS A PIPE . . . BUT FLEXIBLE

circle 295 on Reader Service card, p 103

Marmaduke

Begins on page 140

yelling merrymakers headed by the manager exploded out of the cabaret. The irate manager dashed up to the policeman and viciously tore into that unhappy guardian of law and order, waving his hands wildly as he frantically yelled at the top of his voice.

While the manager stole the show, the captain and Marmaduke exchanged a few hurried words. The two men of action shoved through the milling crowd and jumped into the waiting taxi, leaving the confusion behind.

"Central Quay," snapped the captain to the driver, lighting a cigarette. Turning to Marmy he explained, "now here's the setup. I must sail the *El Dikka* not later than 8 am or I'm in trouble. But that American half-breed fishhead I picked up for an engineer in Tangier this trip hasn't been able to get my diesel-generator set started in two days. You gotta get her going, Marmy, or I'm sunk."

"You just busted up a highly cushey financial deal," put in Marmaduke, as if to strengthen his bargaining position, "but I'll get you out of here all right. I gotta—I need those 200 clams you offered."

"Just so we sail on time," answered Captain Squid, glancing uneasily at his wrist watch as they bumped across the railroad tracks on Bab El Karasta St. Minutes later the cable pulled up at the quay, screeched to a halt. The two men climbed gingerly out and hurried up the gangplank. The *El Dikka* was a small streamlined diesel ship, probably built originally for a luxury yacht.

Walking aft along the deck, the captain led Marmy to the engine-room ladder. They descended to the tiny generator platform.

"This looks like a converted steam schooner," roared Marmaduke, wiping the perspiration from his face when they reached the generator. Looking quickly around he added, "what'd they do, just dump this scrap iron down here and bolt it where it landed?"

"This is my old shipmate Marmaduke Surfaceblow," rasped Captain Squid to a greasy character puttering around the generator. He had a deep

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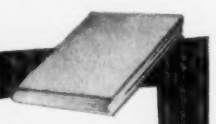

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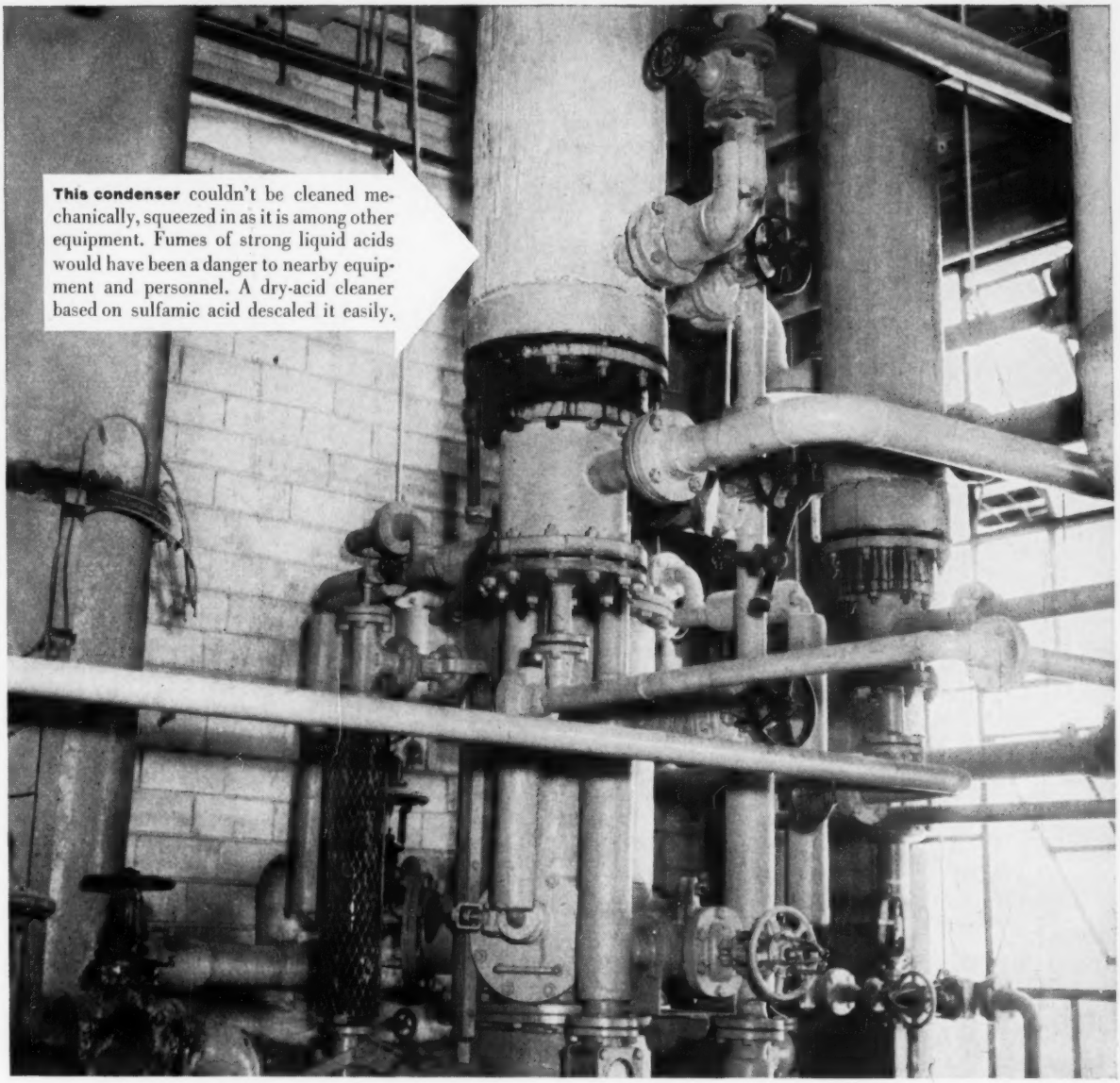

This condenser couldn't be cleaned mechanically, squeezed in as it is among other equipment. Fumes of strong liquid acids would have been a danger to nearby equipment and personnel. A dry-acid cleaner based on sulfamic acid descaled it easily.

Descale equipment in place safely, easily with Dry-Acid Cleaners based on DuPont Sulfamic Acid

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† *U.S. Testing Co. Report #75955, December 26, 1960.* **Patent applied for.*

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Marmaduke

Begins on page 140

scar across his right cheek and an ear was missing. Jerking a thumb at the character, the captain added, "Marmy, this is my engineer. We call him Grade-A for short."

Marmy nodded, then threw his jacket over the instrument-panel handrail, rolled up his sleeves and started to look around. The diesel was a V-12-cylinder solid-injection design of 300 brake hp. It was connected directly to a 200-kw dc generator through a flexible coupling. Two 36-v electric motors were used as starters, attached to the engine block, engaging when starting and disengaging when running.

"What, no air starters on this rust bucket?" suddenly roared Marmy, looking at the engineer.

"Nope," came the answer. Then he added, "These electric starters are sparked by a 1200-amp lead-acid storage battery, and those batteries are grade A, I tell you—I double-checked them."

"Did you relieve the compression in the cylinders?" asked Marmy, hoping to avoid extra work for the battery.

"Everything's grade A," replied the engineer. By then Marmy was barring the flywheel over by hand, just to make sure it turned freely.

"How's your electric switching mechanism?" was Marmy's next question, looking that equipment over carefully.

"Grade A," said the engineer with a snicker on his face.

"Let's go to your battery room," commanded Marmy suddenly.

"I checked both the main and starter battery sets with meters and hydrometers a number of times," volunteered Mr Grade-A, anticipating the next question. "And they are both grade A," he ended up triumphantly.

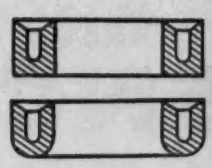
"Now try to start the engine," ordered Marmy, paying no attention to Grade-A's comments. The engineer reluctantly went through all the proper motions of starting the engine, then blurted out with a grin, "you see, she won't start. I told you so."

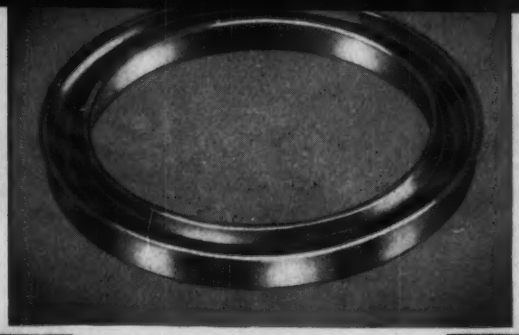
"Yeh, I guess she just doesn't have the oomph," Marmy answered, almost to himself. "Now let's go back to the battery room."

continued

For more facts circle 298 on Reader Service card, p 103

circle 299 on Reader Service card, p 103 ➤





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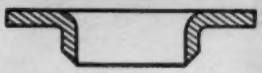

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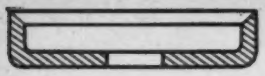

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Those perfect packing rings you see are adding precious extra hours of trouble-free service in countless hydraulic and pneumatic installations everywhere.

Produced in a wide range of sizes for all hydraulic and pneumatic applications. The most appropriate rubber and synthetic compounds, with or without strong duck reinforcement, for use against air, gas, water, oil, chemicals and fluids for specialized applications, assure long life and low friction. Also supplied from high grade leather.

If you need a sturdy heavy duty ring, precision formed, specify Anchor Style #11. For a sensitive softer packing suitable for use with worn or scored cylinders and rods, Anchor Style #43 is ideal.

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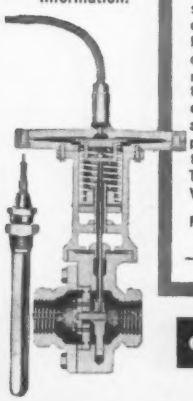

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circle 302 on Reader Service card, p 103

Marmaduke

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"Look here, Mr Big Shot, let's cut out all this kids' play," growled the engineer as they got inside. "These batteries are grade A—I been checking them for two days. Besides," he assured, raising his voice a few decibels, "the old man had a local guy here the other day. He gave those batteries everything but a blood test. Know what he said?"

"Sure, he said they're grade A," shot back Marmy, annoyed. "But when I troubleshoot, I believe no one. This engine won't start—so everything can't be grade A. Now get the lead out and get me a hydrometer," he roared angrily, clenching his fists.

Grade-A was so startled he bolted out of the room and was back in a flash with a hydrometer. Marmy unscrewed a fill plug from a battery cell, played his flashlight beam inside and squinted his eyes.

"There's your trouble," he rasped at the startled man who was watching his every move. "These batteries are fatigue-exhausted. I can tell by the color of both their negative and positive plates."

"She's grade A, I tell you," protested the engineer. With that he grabbed a hydrometer and tested the cell. To Marmy's utter surprise, it indicated "full charge." Marmy looked incredulously at the reading, then checked for himself. He seemed flabbergasted.

"Get me some distilled water," snarled Marmy, eyeing the hydrometer suspiciously. The engineer brought the water and Marmy took a reading. It too indicated full charge.

"Just as I thought," roared Marmaduke.

"Well I'll be a flat-footed mermaid," was all that Grade-A could say. With that he bolted out of the battery room, then came rushing in with three new hydrometers in a carton. He quickly tested each one in the distilled water. Each showed full charge. All four hydrometers were inaccurate. Grade-A looked at Marmy in disbelief.

"You needn't be all fish eyes," reprimanded Marmy. "Some jerk at the factory pulled a boner on the

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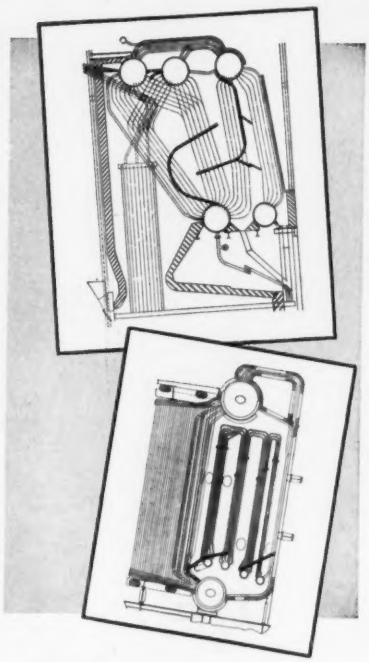

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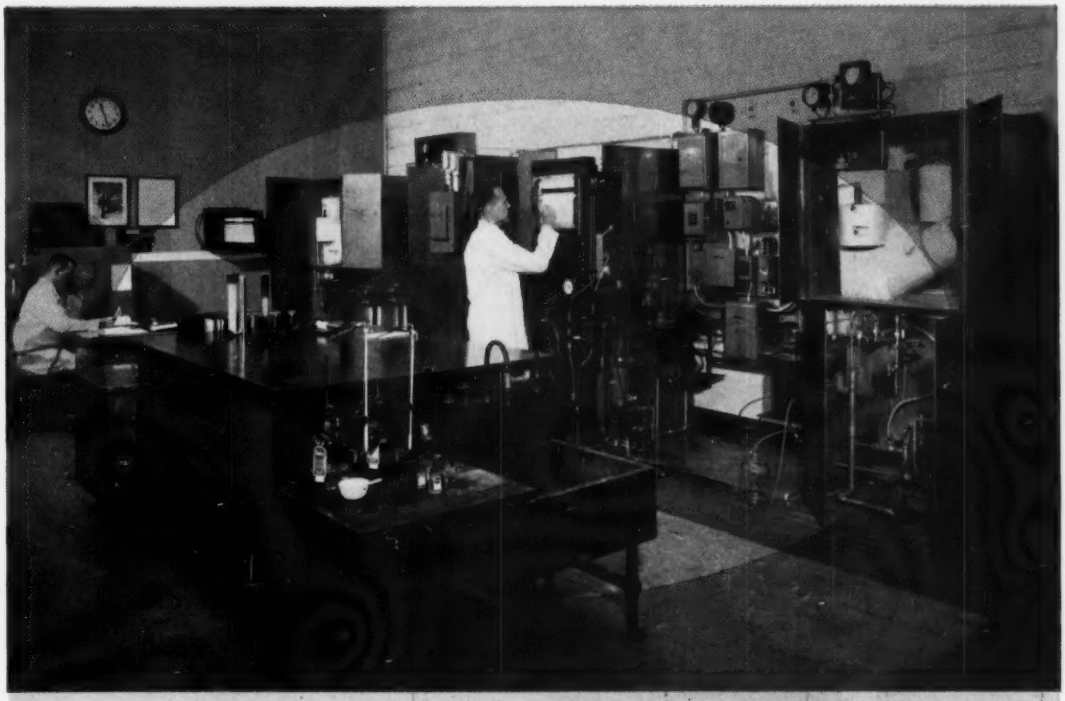
circle 303 on Reader Service card, p 103

These Boilers Generate Ideas



Nalco's general boiler laboratory

Chances are that the *Nalco*® boiler water treatment you are using today came from ideas generated by these unusual experimental boilers. They, like Nalco service, work around the clock producing test data to develop new and improved methods of water treatment. Nalco's research today provides answers to many of tomorrow's problems.

For example—Nalco uses special induction heating techniques to achieve heat transfer rates of 280,000 Btu's per square foot per hour —far higher than present operating units—to establish effectiveness of treatment methods under very severe conditions.

Much of Nalco's experimental boiler work, while less spectacular, is more to the point in most industrial boiler plants: testing the stability of neutralizing amines at high temperatures and pressures, developing effective anti-foams, and exploring the advantages of various organic treatments. These efforts result in constant improvements for *your* water treatment programs.

Technical literature describing some of the problems faced in Nalco's laboratories includes: Reprint Summary 31, The Development of Organics For Water Treatment; Reprint 35, Experimental Boiler Studies of the Breakdown of Amines; and Reprint Summaries 16 & 17, Improvement of Steam Quality & Steam Bubble Formation. This literature is available on request.

If you are not now getting the economic and operating benefits of Nalco water treatment results, ask your Nalco Representative for suggestions as to how Nalco can help you prevent water problems and improve your overall operating cost picture.

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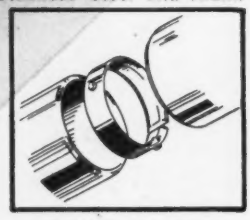

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SINCE 1880

For more facts circle 306 on Reader Service card, p 103

Marmaduke

Begins on page 140

calibrations. When will you guys stop believing everything that has a factory label?"

The engineer hurriedly connected a voltmeter to the starting battery and *it* indicated full voltage.

This time Grade-A looked gleefully at Marmy. "Well, what's your theory now, professor?" he asked sarcastically.

"BILGEWATER on full voltage," roared Marmaduke. "You chowder heads always confuse full voltage with full *charge*. To prove it, try to start the engine again and see what happens to your full voltage."

Grade-A pushed the starting button. Sure enough, the voltage on the meter nose-dived to almost zero like a bos'n's sounding lead plummeting to the bottom.

Just then Captain Squid poked his head into the narrow battery room. "What's the story, Marmy—can you get this generator started?" he asked anxiously. "We got only three hours."

"Everything's shipshape," boasted Marmy, puffing furiously on his cigar butt. "Your starting battery's dead as a sailor after a week's shore leave. But because this guy has been getting phony readings, he hasn't taken the trouble to look further than his bowsprit."

"OK, OK, but what's the answer?" asked Squid impatiently.

"The main battery," shot back Marmaduke. "I'll bet *she* isn't run down." With that he asked for a couple of electric cables. Then he quickly hooked the main battery to the balky diesel's generator to motorize it. The generator, acting like a motor, suddenly started cranking the diesel engine. Marmy opened the fuel throttle slightly and instantly the balky engine roared into lusty life as she started firing. The whole generator platform vibrated violently.

"Hooray," cried Captain Squid above the deafening din. He grabbed Marmy's arm and motioned for him to follow.

A few minutes later in the captain's luxurious suite both men were seated on the leather settee, drinking Sandpaper Gin. The big oscillating fan

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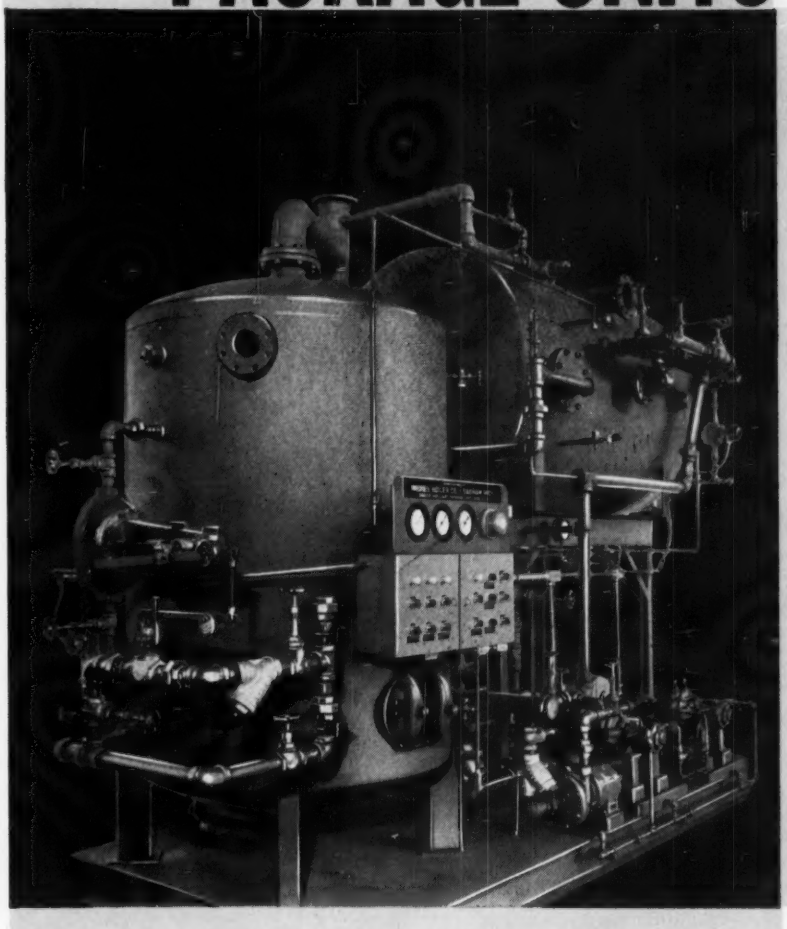

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Write today for Bulletin 59-1, which gives detailed engineering information on all three models of Wickes Boiler Auxiliary Package Units.

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COUNT ON THE NEW W&T SERIES 100 PUMP WHEN YOU NEED...

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Wallace & Tiernan's newest plunger pump delivers 3.2 gph vs 1200 psi to 50 gph vs 100 psi, repeatable within ± 1%. Easy adjustment over 10:1 range with the pump running.

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Marmaduke

Begins on page 140

blew wave after wave of cool, refreshing breeze over them. Marmy suddenly put down his glass and stuffed the 20-piestre banknotes into his pocket as Captain Squid shelled them out.

"Now tell me, Marmy," said Squid after they both drank a toast to the *El Dikka*'s safe departure, "I've seen you do a lot of screwball things, but what in hell was all the horseplay about at the Taufiq Cabaret?"

"Just a gimmick to earn a fast buck and get the wrinkles out of my belly," roared Marmy, busting into violent laughter. "The idea flashed into my noggin on the spur of the moment. You see, Squid, I'm waiting for the *SS Marmara* to come back from Beirut. I went broke last week so I picked up a temporary job as bouncer at the Taufiq. Well, last night potbellied King Farouk waddled in with three female snake charmers. Passing his table I heard him say, 'my kingdom for a horse; what I wouldn't do right now for a horse.' His harem laughed, giving me a brainstorm.

"'What's a horse worth to you, King,' I asked, 'delivered to this table?' He took my bait. Without batting an eye, he waved a 100-piestre note in front of my nose, thinking he had me on the spot. His covey of charmers laughed again.

"Hurrying into the street, I wised up my friend Ali Salama the cop and promised him ten piestres of the loot. That was like waving a blonde in front of a sailor. With the king paying for the laughs, Ali wasn't worried about losing his job," roared Marmaduke.

"Inside of ten minutes Salama was back with that mare," continued Marmy after wetting his whistle. "But the manager wasn't happy and gave the nag's bow end trouble while Ali and I worked on his stern end. That's when you drove up. And when you flashed your SOS," added Marmy, again ballasting his tanks from his glass, "you doubled the ante. I knew I'd have a better chance of picking up some cash by gambling on your engine's horsepower than on the 4-legged variety."—*SME*

For more facts circle 308 on Reader Service card, p 103

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BULKHEAD CONNECTIONS

Only Swagelok has such a complete variety of Bulkhead Tube Fittings. Standard Swagelok Bulkhead Tube Fittings include:

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Swagelok Bulkhead Fittings, like all Swagelok Tube Fittings, are available in any machineable metal or plastic to meet your particular requirements.

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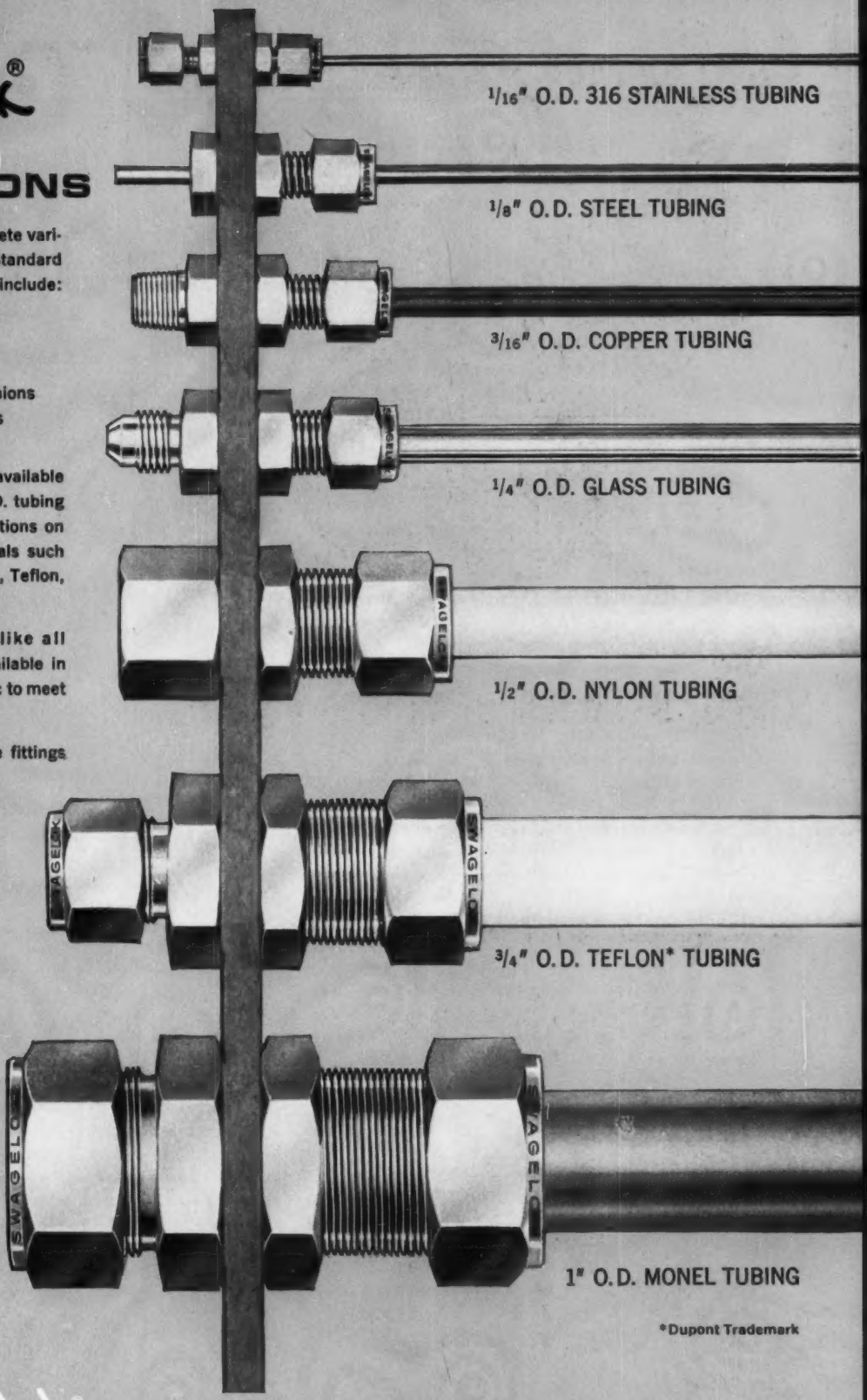
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Powerscope . . . A selective look at

New irrigation project

Most of the hydro and electrical equipment for the Oroville-Wyandotte Irrigation District north of Sacramento, Calif. will be supplied by Allis-Chalmers Mfg Co. The project controls the watershed for irrigation in the south fork of the Feather River and generates nearly 100 mw at key dams in the river. A-C will supply power-generation, transmission and system-control packages including hydro turbines, generators, transformers, switchgear, controls and communication equipment. Upstream Woodleaf powerhouse will have a 6-jet impulse turbine, 71,000 hp at 327 rpm and 1443-ft net head. The central Forbestown plant will have a 39,000-hp Francis turbine running at 450 rpm under 795-ft head. Downstream Kelly Ridge powerhouse will have a 13,000-hp Francis turbine running with a 628-ft head. The packages include standby gas-engine-generator sets. The system is scheduled for operation on January 1, 1963.

Probing the atom

Dr J Rand McNally Jr of the Oak Ridge National Lab reported research he did on arc plasmas ranging from 40,000 to over 1,500,000 F in temperature. In studying a Luce arc —a low-pressure high-current arc between carbon electrodes in a strong magnetic field —he found the electrons had temperatures of 40,000 to 100,000 F. On the other hand the heavier positive ions had temperatures ranging from 200,000 to more than 1,500,000 F. The ions rotate about the arc axis like a tornado, but at particle speeds about 100 times greater. With ions hotter than electrons in plasmas, the radiation produced by electron collision—bremsstrahlung—is not as important as originally thought.

Land for the future

Consumers Power Company has options to buy several hundred acres bordering Lake Michigan about three miles south of Ludington. This will possibly be used for a pumped-storage hydro plant. The land to be acquired has an elevation about 300 ft above Lake Michigan. Capacity of plant and reservoir is still to be decided—site may not be used for several years to come.

Gas from coal?

Under present competitive conditions coal is not the most economical raw material for producing either synthesis gas or high-Btu pipeline gas, says Martin A Elliott, Director of the Institute of Gas Technology. However, in the opinion of many people the production of high-Btu gas from coal will be needed in 10 to 20 years to supplement our supplies of natural gas.

Engineers' salaries continue up

Engineers' salaries rose about 5% per year between 1958 and 1960 according to the survey by the Engineering Manpower Commission of the Engineers Joint Council. The survey, "Professional Income of Engineers—1960," covers about 200,000 engineering graduates. Median age of the group is about 32 based on graduation average age of 22 years. Median salaries grew as follows: $6500 in 1953; $7750 in 1956; $8750 in 1958; $9600 in 1960. Variation with experience and type of activity for median salaries as of 1960 were reported as:

Years of	*Median annual salaries, dollars*		
experience	*Industry*	*Education*	*Government*
1	6775	5375	6275
5	8200	7350	7175
10	9975	9100	8750
15	11,250	10,950	9075
28	12,575	12,575	10,650

Copies of the report can be bought from the Engineering Manpower Commission, 29 West 39th Street, New York 18, N.Y. at $3 each.

Consultant leases computer

Pioneer Service & Engineering Co has leased an IBM-1620 computer to use in its studies, the first time this unit has been used in the electric-utilities industry. Unit takes as much space as a drafting table and has a magnetic-core memory for 20,000 bits of data—capability to be expanded to 60,000 bits. It reduces calculating time by as much as 75% in making system-expansion studies. In addition to this work the computer will be used for studies of power-plant computer control, production control, stock transfer, payroll and depreciation studies.

Britain gives record order

Britain's Central Electricity Generating Board has placed record orders totaling $95.2 million with International Combustion, Simon-Carves Ltd and English Electric Company Ltd for the new West Burton Power Plant. The first two firms will supply four 3.4-million-lb-per-hr steam generators with controlled circulation. EE will supply four single-

shaft 500-mw turbine-generators with condensers, and steam-turbine-driven boiler-feed pumps. The main units are the largest ever built in Europe and may be largest in the world of their type. First unit is scheduled to start June 1965, to be followed at 9-month intervals by the remaining units. Total station cost is estimated at $84 to $112 per kw capacity. (*McGraw-Hill World News*)

Bridge supports conveyor belt

Snake River in Washington State is now crossed by a 930-ft suspension bridge. A miniature modeled on San Francisco's Golden Gate, this bridge was built for the sole purpose of supporting a conveyor belt. The endless belt, supplied by B F Goodrich, hauls sand, gravel and rock for U.S. Army Corps of Engineers' Ice Harbor Lock and Dam project. The 30-in. conveyor-belt tramway carries 660 tons of aggregate per hr, traveling at 300 ft per min. Total belt length: 2400 ft.

Anti-smog auto muffler

First formal application for a California State test of an anti-smog device for automobiles has been filed by Universal Oil Products Co of Des Plaines, Ill. The testing program may result in certification of at least two exhaust devices by the end of this year. Los Angeles County air-pollution controllers hope that approved devices will be mandatory on all cars starting with the 1963 models.

Universal's device is a catalytic muffler designed to reduce hydrocarbons and CO in auto exhausts to the level set by law. The company says its "Purzuast" muffler will be priced about $50 above standard mufflers. With average mileage it will have to be replaced every two years.

Reaching for the sky

A 630-ft reinforced-concrete chimney, tallest in the Eastern states, is being built by The Rust Engineering Company at the Shawville Station of the Pennsylvania Electric Company. Construction started in February and rises in 7-ft 6-in. sections of poured concrete 36-in. thick. Bottom outside dia of 37 ft 6 in. tapers off to 19-ft 2-in. dia at the top where the chimney wall is 8-in. thick. The new chimney replaces two stacks 200-ft tall now serving two steam generators. Using an electronic computer for design of the chimney allowed starting construction three weeks earlier than with the old hand methods.

Thin-film desalting

General Electric Company has demonstrated the feasibility of a water-desalting system using an assembly of revolving blades resembling an auto's windshield wipers. The water vaporizes without boiling or bubbling. Testing of more than 1000 hr, including a continuous run of about 130 hr, has produced fresh water with less than 1-ppm salt. Testing used more than 175,000 gal of sea water. The clean-tube heat-transfer rate was at least four times higher than any achieved in commercial distillation units now used. System can extract 42-lb fresh water per 100-lb sea water. The evaporator consists of two vertical tubes, one inside the other. The wipers, turning at low speed, spread the sea-water feed on the inner surface of the inside tube in a film about 1/1000-in. thick. Steam flowing in the annular tube space vaporizes the fresh water; concentrated brine drains out the bottom. The experimental work is being done under contract for the Office of Saline Waters and the Bureau of Ships at a cost of over $100,000.

Industrial expands capacity

The Crossett Company, maker of diversified wood products at Crossett, Ark., will expand its electric-generating capacity at a cost of $4 million on recommendation of Ebasco Services Inc. They will add a 20-mw turbine-generator, a 300,000-lb-per-hr bark-and-gas-fired boiler, systems for conveying waste fuel to the boiler and expanded electric- and steam-distribution systems. This will raise plant capacity to 1-million-lb steam per hr and 36 mw of electric power. Rust Engineering Co is preparing plans for the expansion. Work will be completed in two years. (*McGraw-Hill World News*)

U.S.S.R. plans superpressure plant

The Soviet is planning a plant of four cross-compound steam turbines each rated 600 mw. Cycle will use 4300-psig 1160-F throttle steam and two 1050-F reheats. Plant will burn lignite with a heating value of 5300 Btu per lb at moisture of 35% and 16% ash. Boilers will evaporate 3,800,000-lb steam per hr. Annual fuel consumption will total about 12-million tons. Expected thermal efficiency will range 40 to 43%. (*McGraw-Hill World News*)

Argentina's national railways has ordered nearly seven miles of glass-insulated cable plus other substation equipment from GE.

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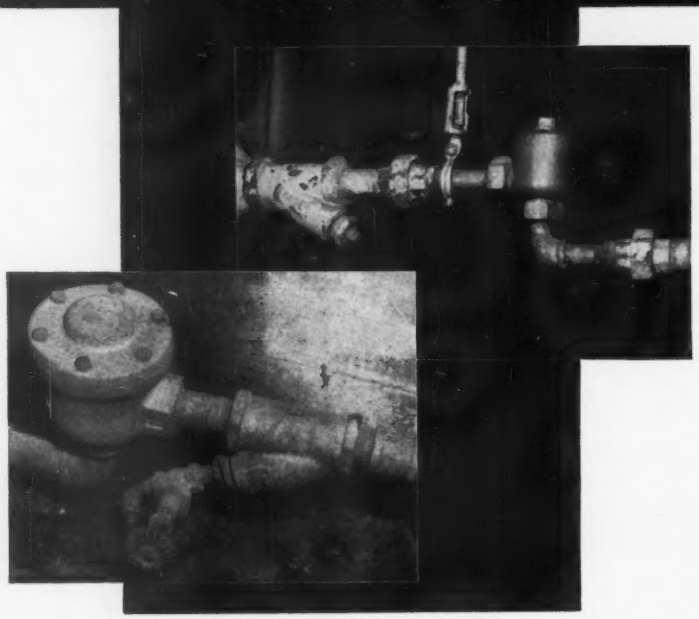

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Powerscope

Begins on page 152

Expansion joint saves menaced water line

At the U. S. Navy Electronics Lab, Point Loma, Calif., the ground was separating at a rate of 5/8 in. a month creating a ravine that traversed the path of a 6-in. bell-and-spigot water pipeline. The earth separation was of undetermined origin. Stress on the line caused frequent breaks.

Earlier this year a 150-lb 6-in. semiguided single expansion joint was installed which seems to have solved the pipeline problem. Joint has a 16-in. traverse giving ample allowance for separation before resetting.

Joint was installed where the line was already exposed and could easily be watched. When the joint has opened to about 14 in., the flange on one end will be unbolted and the joint forced closed. A spool will be slipped into the 14-in. gap and water will flow again.

With the joint closed, sleeve will still present a dense surface to the packing. Although friction in the packing would resist the opening motion at 550 lb, 34.5 sq in. of internal sleeve face times 60-psi water pressure counteracts friction with force of 2055 lb. Difference of 1505 lb acts as spring to hold constant thrust axially against the bell-and-spigot joints and prevents leakage or separation.

Glass tube facilitates study of h-t gases

Boeing Scientific Research Labs in Seattle, Wash. are conducting tests with a hydromagnetic glass tube in their study of h-t gases. Shock waves are driven through tube by a surge of electrical power equal to the output of four Grand Coulee Dams. Electrical energy used to create the waves is stored in two 20-capacitor banks rated 20,000 v. The triggered shocks create a gas temperature within the tube of about 1-million F. Thermal and magnetic energy in electrical discharge create shock waves traveling 80 times the speed of sound.

Velocity of waves and spectra of radiation from gas are recorded with

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The CP design gives you more steam capacity per cubic foot of space occupied, greater furnace volume with less head room. Keeler "water walls" provide extra heat absorbing surface—and absorb more BTU's per square foot from the radiant heat of the fire. Staggered tube spacing gives you maximum heat transfer. Free, natural water circulation—without internal baffles—permits operation at high overloads with exceptionally dry steam, and with no disturbance of water level.

Available in capacities to 150,000 lbs stm/hr for any method of firing, all types of fuel (and readily convertible). Many shop assembled sizes. *Write or phone for the full economy story . . .*

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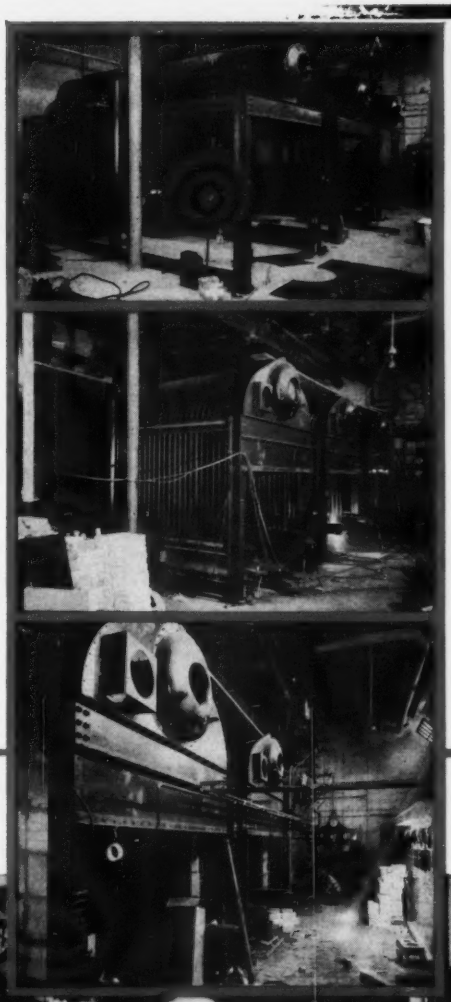
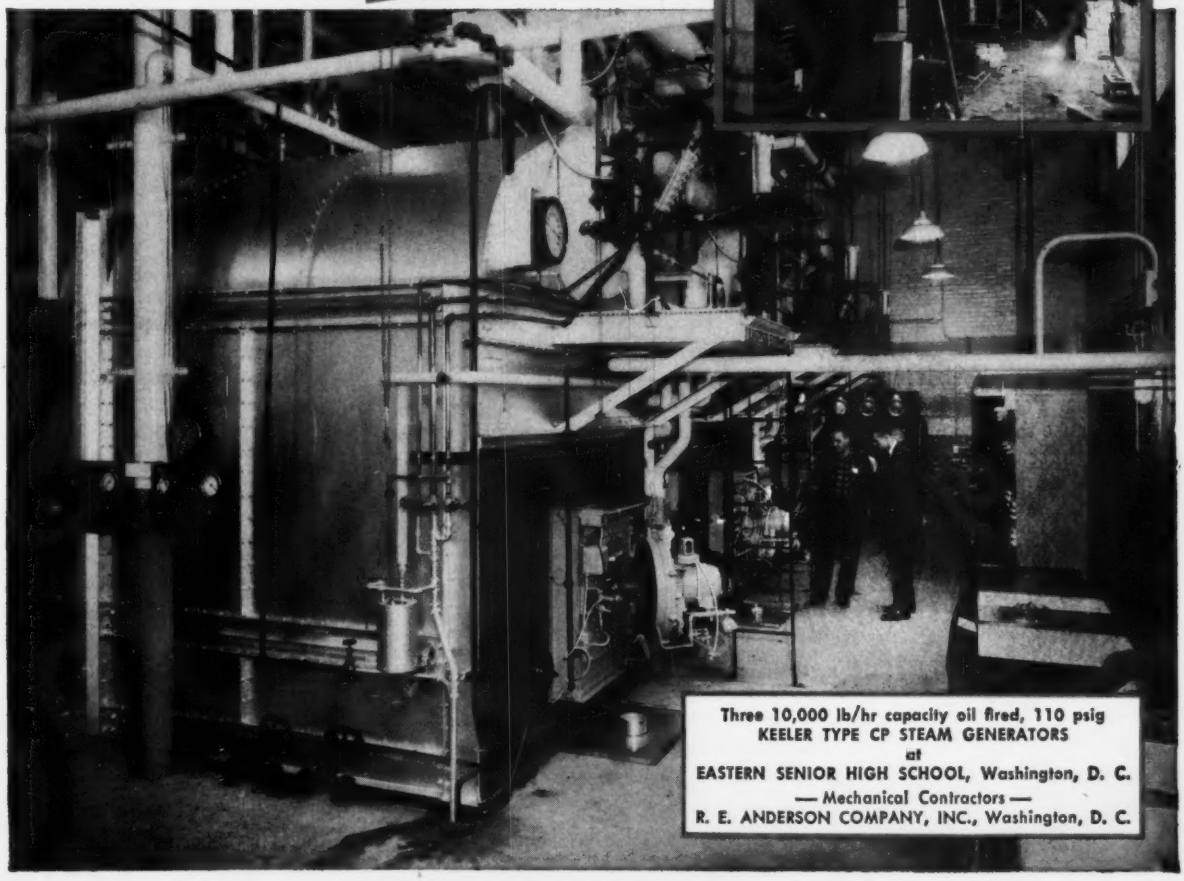
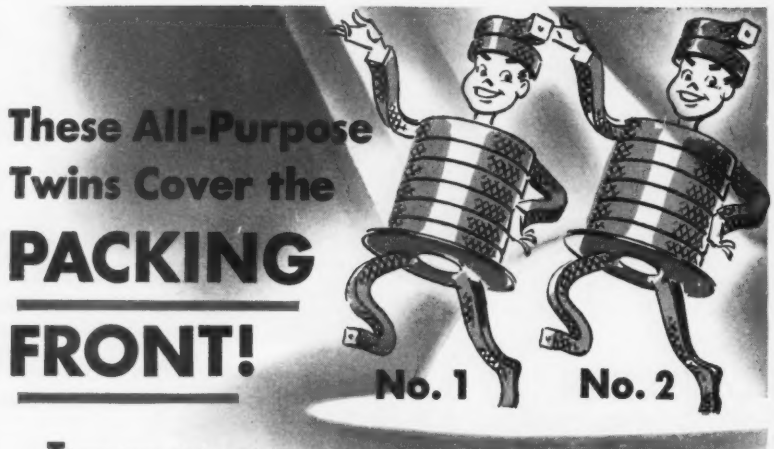
KEELER WATER TUBE Boilers





Three 10,000 lb/hr capacity oil fired, 110 psig
KEELER TYPE CP STEAM GENERATORS
at
EASTERN SENIOR HIGH SCHOOL, Washington, D. C.
— Mechanical Contractors —
R. E. ANDERSON COMPANY, INC., Washington, D. C.

For more facts circle 311 on Reader Service card, p 103



These two styles of Allpax Packing cover a wide range of applications and many different uses, consistent with the policy of our company—fewer packings for more services.

Both are compounded of the highest quality materials, and between them they cover against such service conditions as steam, water, air, ammonia, gases, oils, distillates, dowtherm, etc. They are for use on centrifugal and rotary pumps, valve stems, expansion joints and similar equipment.

Packaged in durable metal containers to insure protection and preservation of material. Applications and uses conveniently noted on each container.

Style No. 1 is really universal in its uses—where the temperature does not exceed 600 degrees F.

Style No. 2 also has an extremely wide variety of uses in higher temperatures, ranging from 600 degrees F. to 1200 degrees F. This is because of a special bonding compound, containing a heat-proof lubricant, which maintains the lubricant under high temperature conditions.

Both types are made in ring, spool or coil form in a wide variety of sizes. Allpax Packings do a better job for manufacturers and replacement use because they are precision-made, accurate in dimensions. They provide a tight seal without danger of scoring or unnecessary wear.

ALLPAX

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SEND FOR OUR NEW CATALOG — TODAY!

A complete line of packing, tools, gasket materials.
Distributors in principal cities.

THE ALLPAX COMPANY, INC.
160 Jefferson Ave., Mamaroneck, N. Y.
CANADIAN DISTRIBUTORS: Albion Asbestos Packings Ltd., Montreal 8, Quebec

Powerscope

Begins on page 152

high-speed rotating mirror camera. Boeing uses a new vacuum ultraviolet spectrograph which separates light into its components to evaluate the data.

Shock-tube program studies could have important results in developing effective ion and plasma-propulsion systems. The tube is expected to be useful in measuring temperatures of gases up to several million degrees and in study of microwave emission and energy loss through radiation.

Cask car provides fuel for Fermi reactor

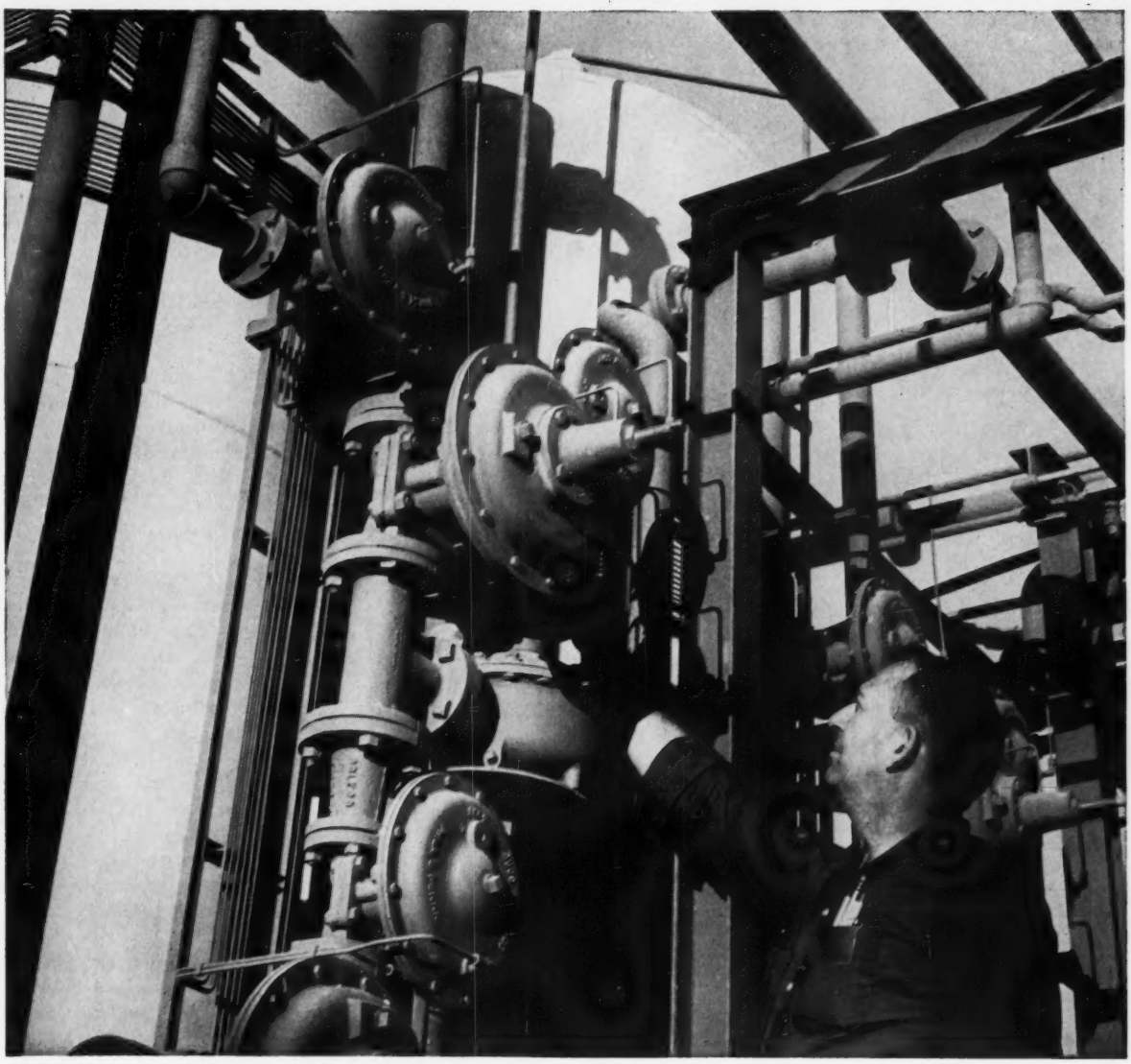
Self-propelled $700,000 transfer cask car for loading atomic fuels and removing radioactive wastes is a major component of the Enrico Fermi Atomic Power Station at Stony Creek, Michigan. Fermi Station, scheduled for operation late in 1961, will be first commercial atomic power plant using fast neutrons with liquid sodium metal as a coolant and heat-transfer mechanism.

Car provides means for replacing spent elements in reactor with fresh fuel and transporting fuel assemblies to and from storage areas. Handling and carrying is accomplished in large shielded cylinder section. Heat-transfer system preheats fresh fuel elements and dissipates radiation heat from spent elements.

Cab houses operator, instruments and controls. Some 11 fresh fuel assemblies are accommodated in cask in a rotating device. Gripper and hoist transfer fuel assemblies between device and reactor receiving system.

En route to Fermi Station, heavily insured and guarded car moved only during day, never above 24 mph.

Employees of Edge Moor Power Station, Delaware Power & Light Company have racked up high safety record. From May 1952 to December 1960 there have been no chargeable accidents in 2,000,000 man-hours.



California Electric Power Company's generating station, Yuma, Arizona

SARAN LINED PIPE carries 10,000 gallons per day of "hungry" water to feed high-pressure boiler

At California Electric Power Company's generating station above, a quarter-mile of Saran Lined Pipe feeds highly active deionized water to a high pressure boiler system. This "hungry" water attacks unprotected iron and steel pipe, corroding enough metal to put the boiler and steam turbine out of business and causing such damage to the piping that it must eventually be replaced.

Station Superintendent A. A. Lingo says, "We specified Saran Lined Pipe and valves for this application because, from experience, we knew we could depend on its corrosion resistance. Another important, though not primary, basis for our choice was the reasonable over-all cost of a Saran Lined Pipe installation."

This installation contains nearly 1200 feet of Saran Lined Pipe, 400 feet of it in a vital demineralizing unit. The remainder carries the deionized water to 300,000-gallon storage tanks, and from there to the steam generator. Saran Lined Pipe combines high corrosion resistance and high physical strength. It requires minimum external support on straight runs and little or no maintenance even after years of carrying highly reactive materials.

Saran Lined Pipe, fittings, valves and pumps are available for systems operating from vacuum to 300 psi, from below zero to 200° F. They can be cut, fitted and modified easily in the field without special equipment. For more information, write Saran Lined Pipe Company, 2415 Burdette Avenue, Ferndale, Michigan, Dept. 1569DW4.

THE DOW CHEMICAL COMPANY DOW Midland, Michigan

For more facts circle 313 on Reader Service card, p 103

RIDGID®

65R-TC

RATCHET THREADER

with new True-Centering Workholder

Gives Better Threads Faster 4 Ways!

Here's Why:

One set of dies threads 1", 1¼", 1½" and 2" pipe and conduit . . . no dies to change. • Fast-to-set, True-Centering Workholder centers dies for true threads every time • Easy adjustment for accurate "drip" threads • It's jam-proof . . . automatic kick-out —prevents jamming.

RIDGID 65-RC with Cam-Type Workholder Also Available.

Call your Distributor today. For your convenience, he maintains a complete stock of RIDGID Work-Saver Pipe Tools and parts!

RIDGID

The Ridge Tool Company, Elyria, Ohio, U.S.A.

Calendar

April 10-11 — American Society of Mechanical Engineers, Maintenance & Plant Engineering Conference, Bancroft Hotel, Worcester, Mass. Details: ASME Meetings Dept, 29 W 39th St, New York 18, N. Y.

April 10-12—American Institute of Mining, Metallurgical and Petroleum Engineers, Open Hearth & Blast Furnace Conference, Sheraton Hotel, Philadelphia, Pa. Details: AIME, 29 W 39th St, New York 18, N. Y.

April 10-21—American Welding Society, 42nd Annual Convention and Welding Exposition, Sheraton-Atlantic Hotel, Coliseum, New York, N. Y. Details: Information Center, AWS, 33 W 39th St, New York 18, N. Y.

April 17-19—Instrument Society of America, 7th National Symposium on Instrumental Methods of Analysis, Shamrock-Hilton Hotel, Houston, Texas. Details: ISA, 313 Sixth Ave, Pittsburgh 22, Pa.

April 23-26—American Society of Mechanical Engineers, Metals Engineering Conference, Penn Sheraton Hotel, Pittsburgh, Pa. Details: ASME Meetings Dept, 29 W 39th St, New York 18, N. Y.

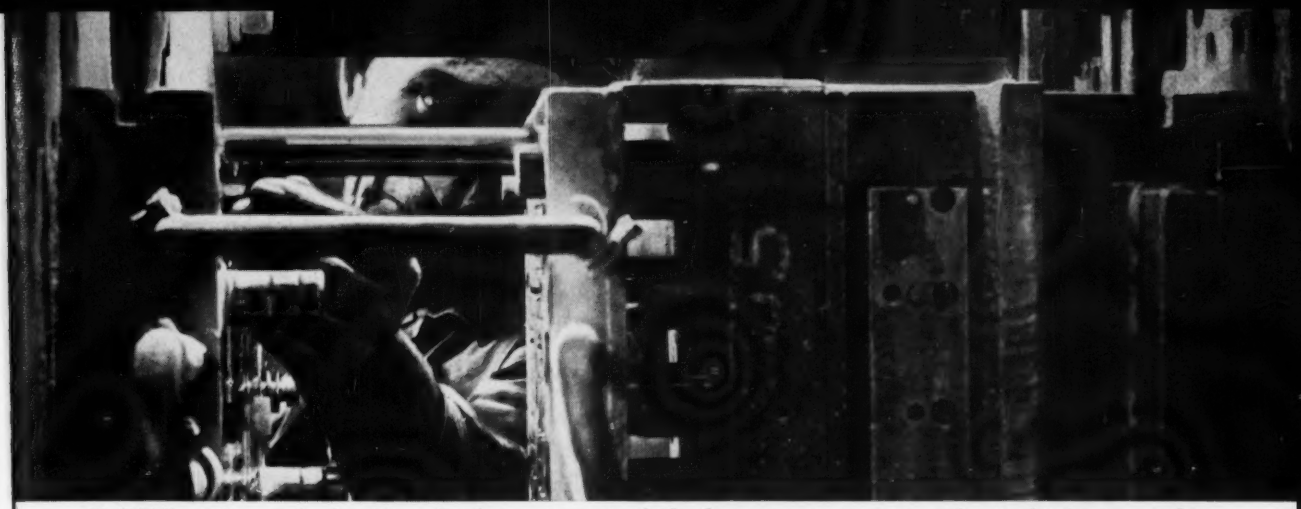
April 23-26—Oil Heat Institute of America, Inc, 39th Annual Meeting, Statler-Hilton Hotel, Washington, D.C. Details: OHI, 500 Fifth Ave, New York 36, N. Y.

April 26-27 — Metallurgical Society of AIME, National Technical Conference on H-T Materials, Pick-Carter Hotel, Cleveland, Ohio. Details: Metallurgical Society of AIME, 29 W 39th St, New York 18, N. Y.

April 30-May 3 — Electrochemical Society, Meeting, Claypool Hotel, Indianapolis, Ind. Details: Electrochemical Society, 1860 Broadway, New York 23, N. Y.

May 1-3 — Electric Association, Lighting Exposition, Lake Front Ex-

For more facts circle 314 on Reader Service card, p 103



Shell Tellus Oils are refined and formulated to meet exacting hydraulic service requirements, such as in this forming machine.

PHOTO COURTESY ATLANTIC PLASTICS INC., STAMFORD, CONNECTICUT

BULLETIN:

Shell provides a quick 6-point check list for hydraulic oils: Use it to pick the right oil for your needs

Selecting the proper hydraulic fluid for your equipment can be one of your most important decisions. And it can pay off in many ways. Less down time. Lower cost per unit. Longer equipment life.

Here are six bench marks to help you pick the best hydraulic oil for your plant requirements.

1. Does it have good oxidation stability? Oxidized hydraulic oil can form gums, lacquers and other deposits which may foul moving parts. Shell Tellus Oils are carefully refined to remove unstable, sludge-forming components, then fortified with a Shell-developed oxidation inhibitor.

2. Will it resist foaming and emulsification? Pump chatter and erratic operation are often the result of pump cavitation, brought on by oil foaming. Tellus® Oils contain powerful additives to help prevent foaming.

They also contain a selected inhibitor to combat effects of moisture that might be in the system.

3. Does it fight rust and corrosion? It is difficult to exclude all moisture from a hydraulic system. And moisture can form troublesome rust. Shell Tellus Oils have been carefully compounded to resist corrosion.

4. What are its lubrication qualities in continuous service? Shell Tellus Oils form a clinging, oily film on mating metal surfaces. This maintains a constant guard against wear.

5. How does it react to temperature changes? This is a key factor in the performance of hydraulic equipment. Careful selection of the proper viscosity grade of Tellus assures satisfactory operation of your system over its entire temperature range.

6. Is it available in several viscosity grades? Shell Tellus Oils are available in a broad range of viscosity grades. There's a special grade for virtually every hydraulic requirement.

Ask your Shell Industrial Products Representative for facts on Tellus Oils. Or write: Shell Oil Co., 50 West 50th St., New York 20, N. Y.

A message to manufacturers of hydraulic equipment

There is a Shell Tellus Oil suited for your equipment.

1. Your customers can get Tellus Oils at Shell depots everywhere. Readily available throughout the world.

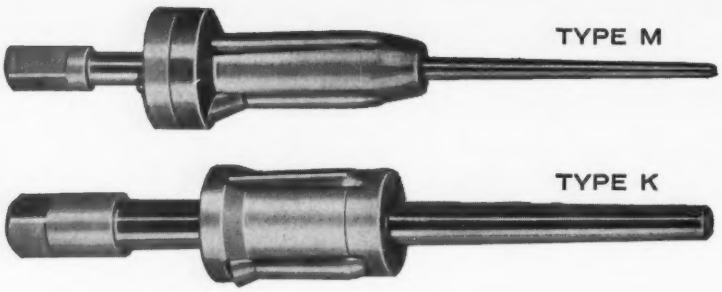
2. Quality is consistently high. Tellus always delivers top performance.

SHELL

A BULLETIN FROM SHELL
—where 1,997 scientists are working to provide better products for industry

write for your copy of this Bulletin!

ELLIOTT
Boiler Tube Expanders
for tubes 3/4 in. I.D. and up



This 16-page bulletin describes general types of Elliott boiler tube expanders for fast, efficient tube rolling jobs. It also gives dimensions, prices and other descriptive data and shows various drum, header and short series mandrels which are used with Elliott boiler tube expanders. Drum mandrels are seen with Type M and Type K above.

Accessories available to adapt Elliott boiler tube expanders to various tube rolling applications include universal joints and extension shafts, sockets, gear drives, etc. A heavy-duty, right-angle gear drive utilizes roller bearings to minimize friction, cutting down power losses.

RIGHT-ANGLE GEAR DRIVE▸
Available in ½, ¾ and 1-in. sizes

Write the Elliott Company, Lagonda Operation, Springfield, Ohio, *today*, for your copy of Bulletin Y-46-A.

Y1-7

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GENERAL OFFICES: JEANNETTE, PENNSYLVANIA
PLANTS AT: Jeannette and Ridgway, Pa.; Springfield, Ohio
TURBINES • GENERATORS • MOTORS • COMPRESSORS • TURBOCHARGERS
DEAERATING HEATERS • EJECTORS • CONDENSERS • STRAINERS • TUBE CLEANERS

Calendar

Begins on page 158

position Hall, Chicago, Ill. Details: Electric Association, 140 S Dearborn St, Chicago 3, Ill.

May 1-4—Rural Electric Generating Cooperatives, 12th Annual Conference, Battle House Hotel, Mobile, Ala. Details: D E Smithson, Alabama Electric Cooperative, Inc, Andalusia, Ala.

May 8-9 — American Society of Mechanical Engineers, Lubrication Symposium, Deauville Hotel, Miami Beach, Fla. Details: ASME Meetings Dept, 29 W 39th St, New York 18, N. Y.

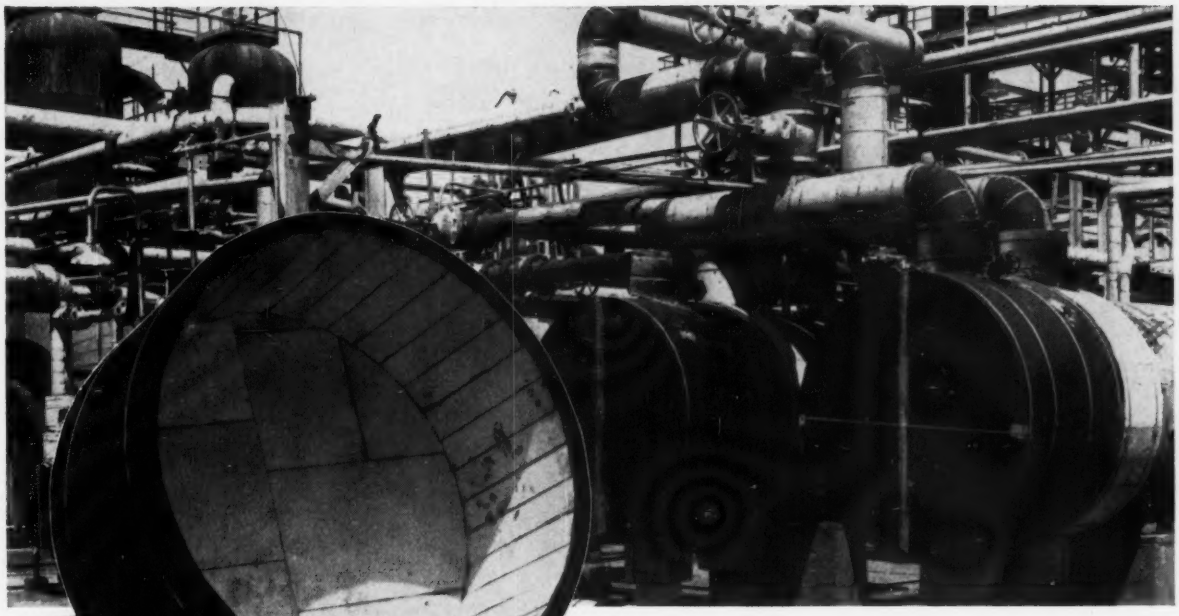
May 7-10 — American Institute of Chemical Engineers, Meeting, Sheraton-Cleveland Hotel, Cleveland, Ohio. Details: AIChE, 25 W 45th St, New York 36, N. Y.

May 7-11—American Society of Mechanical Engineers, Hydraulic Conference, Queen Elizabeth Hotel, Montreal, Can. Details: ASME Meetings Dept, 29 W 39th St, New York 18, N. Y.

May 8-10 — Instrument Society of America, 4th National Power Instrumentation Symposium, LaSalle Hotel, Chicago, Ill. Details: Meetings Manager, ISA, 313 Sixth Ave, Pittsburgh 22, Pa.

May 9-11—Annual Western Joint Computer Conference, National Joint Computer Committee—Institute of Radio Engineers, American Institute of Electrical Engineeers, Association for Computing Machinery, Ambassador Hotel, Los Angeles, Calif. Details: Dr W F Bauer, Thompson Ramo Wooldridge, Inc, Ramo-Wooldridge Div, 8433 Fallbrook Ave, Canoga Park, Calif.

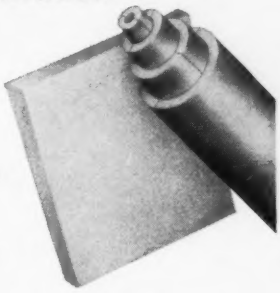
May 10-12—Pulp and Paper Instrumentation Symposium, sponsored by ISA, TAPPI, Northland Hotel, Green Bay, Wis. Details: Meetings Services Dept, ISA, 313 Sixth Ave, Pittsburgh 22, Pa.



Number 3 was down for turnaround so

Humble cut deadweight, saved time and money with new UNARCO U-200

low temperature insulation



When Number 3 Alkylation Unit was brought down recently at Humble's Baton Rouge refinery, they threw away the old insulation. It was replaced by U-200, a new, lightweight, rigid polyurethane foam insulation for temperature ranges of —300°F to +220°F. Significant savings in Humble's cold service insulation resulted. Here's why:

Lowest K Factor—0.14 at 70° mean temperature. Required half the usual insulation thickness, fit where space was limited.

Lightweight—U-200's extremely low density (2.3 lbs. per cu./ft.) reduced deadweight on bulky heat exchanger.

High strength—U-200's compressive and flexural strength permitted inner surfaces to be scored for bending and shaping without breakage.

Easy to apply—U-200 was cut to size with hand tools and shaped to fit smoothly around flanges and valves. Is non-toxic and has excellent heat and chemical resistance.

Available in accurate, half-round sections; in nominal thicknesses and in standard pipe sizes. Individual sections 36 inches long. Also available in 12" x 36" block form—1" to 5" thickness in ½" increments.

Write Today for Unarco Bulletin U-200

U-200 *The insulation with "Handleability"*

POLYURETHANE FOAM

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UNARCO PRODUCTS

• UNIBESTOS, Amosite Asbestos Pipe Covering and Block • Calcium Silicate Pipe Covering and Block • 85% Magnesia Pipe Covering and Block • Mineral Fiber Block • Wrap-On Insulation • Lace-On Insulation • Turbine Blankets • Insulating and Finishing Cements • Asbestos Textiles • Packing and Gasketing.

UNION ASBESTOS & RUBBER COMPANY

Fibrous Products Division • **Dept. 289, Bloomington, Illinois.**

For more facts circle 317 on Reader Service card, p 103

Basic Safety Controls for Low Pressure Steam Boilers—Answers all safety control problems that arise in low pressure steam field. The full story of correct hook-up and proper wiring in simple statements and clear diagrams.

Basic Safety Controls for Hot Water Space Heating Boilers—Companion piece to "steam" book opposite. Correct solution of all safety control problems in the area of hot water space heating boilers.

McDonnell Flow Switches—Points out the almost endless uses of flow switches for safety control and automatic control. Covers all details of construction, service ranges, applications.

Special Applications of McDonnell Products—Twenty-one case studies of simple control problems that turn up in any plant. Each case suggests others. Liquid level control and flow problems are clearly defined and met.

—for every engineer

Here are four bulletins that can make a basic contribution to the things every operating man seeks...more efficient operation... automatic operation...safer operation.

Read the brief descriptions of these booklets. ***Use the coupon to request any or all of them.***

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Appointments

Management changes

Air Reduction Sales Co: A S Blodget Jr, vice-president of midwestern region. **Atomics International:** Dr W E Parkins, associate technical director. **Bechtel Corp:** S D Bechtel Jr, president. **Black, Sivalls & Bryson, Inc:** W C McCool, manufacturing vice-president. **Bunting Brass and Bronze Co:** R O Oyler, director of sales. **Crane Co:** H R Riggs, vice-president.

Fairbanks, Morse & Co: T G Lanphier Jr, president. **Gilbert Associates Inc, Nuclear Energy Div:** G W Switzer Jr, manager. **H K Porter Co, Inc, Peerless Electric Div:** W A Curtis, general manager; S G Powers, general manager of National Electric Div.

Hewitt-Robins, Inc: H M Ross, vice-president; E F Emmons, board of directors. **Jackson Moreland, Inc:** J R Coffin, president. **A Lynn Thomas Co, Inc:** R M Dillon, executive vice-president and general manager. **Melpar, Inc:** Dr E A Walker, board of directors. **Nalco Chemical Co:** D M Jacks, T G Cocks — vice-presidents. **Permutit Water Conditioning Inc:** H I Edwards, general manager.

Public Service Gas and Electric Co: F Freer Jr, vice-president. **Union Electric Co:** G V Williamson, vice-president of operations. **Western New York Nuclear Research Center Inc:** Dr C C Furnas, president and board chairman. **Worthington Corp:** D C Power, F J Nunlist, board of directors.

Institute elections

European Organization for Nuclear Research (CERN): J Willems, representative of Belgium, president for 1961; E Amaldi, representative of Italy, J H Bannier, representative of Netherlands, vice-presidents. **Electric Overhead Crane Institute, Inc:** W W Peattie, president. **National Association of Corrosion Engineers:** E C Greco, president.

continued

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Write for Folder PF-2 for complete data on quantities and weights of the items as packaged in various sizes of cartons. Address Dept., 24 A-FP.

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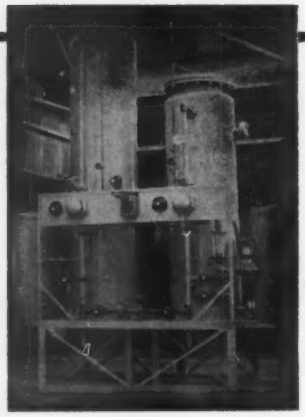
Forged Steel FITTINGS, FLANGES and UNIONS

For more facts circle 319 on Reader Service card, p 103



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Low-Cost • High-Performance
"PACKAGE" DEMINERALIZERS!
TWO-BED and UN-A-BED STANDARD UNITS
NOW AVAILABLE!!

Unless *special* conditions require you to use a *special* demineralizing system, you can save big money—and get excellent results—with the new H&T Standard "PACKAGE" DEMINERALIZER! Into these superior Standard Units, we've put the experience of 16 years in building many hundreds of manual and automatic demineralizing systems. *Result:* H&T "PACKAGE" DEMINERALIZERS are masterpieces of design and construction—unequalled in performance and wonderfully low in cost.

Write for details of Two-Bed and Un-A-Bed Demineralizers

H&T SERVICE

HUNGERFORD & TERRY, INC.
CLAYTON 3, NEW JERSEY

For more facts circle 320 on Reader Service card, p 103

WHEN YOU NEED HELP IN A HURRY—

Koppers coupling service cuts costly down-time

Not every coupling service need is an emergency. But it's the emergencies that really test a good organization. That's why Koppers maintains experienced field engineers and outstanding stock facilities throughout the country. In addition, if it's a Fast's Coupling you're replacing, we have a serial number and specific application history for every Fast's for easy reordering. And our modern manufacturing facilities have the extra capacity to lick an emergency for special requirements.

Example: A modern windowless bank in Georgia was able to open for business as usual only because Koppers flew in a completed replacement coupling for its air conditioning unit. Elapsed time . . . request phoned to Baltimore after 10 in the evening . . . coupling arrived before 7:30 next morning.

KOPPERS COMPANY, INC., 1104 Scott St., Baltimore 3, Md.

KOPPERS

FAST'S COUPLINGS
Engineered Products Sold with Service

For more facts circle 321 on Reader Service card, p 103

Appointments

Begins on page 162

Purchase & merger

Magnaflux Corp: acquisition of Metal Control Laboratories. **McGraw-Hill Publishing Co:** acquisition of F W DODGE Corp. **Parker-Hannifin Corp:** purchase of Span Brass Mfg Co and Spanco Brass Sales Co. **Schaevitz Engineering:** asquisition of Smith & Macgeorge. **SKF Industries, Inc:** purchase of Nice Ball Bearing Co. **Square D Company:** purchase of Gorham Mfg Co. **Wallace & Tiernan Inc:** approval to merge with R J Strasenburgh Co. **Worthington Corp:** consolidation of Wintroath Pumps and Vertical Turbine Pump Divisions into Vertical Pump Div.

New name

Yellott Solar Energy Lab was established last Nov by John Yellott Engineering Associates, Inc to carry out research, development and testing programs for industry and research institutions. Located in Phoenix, Ariz., the lab will provide a consulting-engineering service in the field of solar-energy utilization.

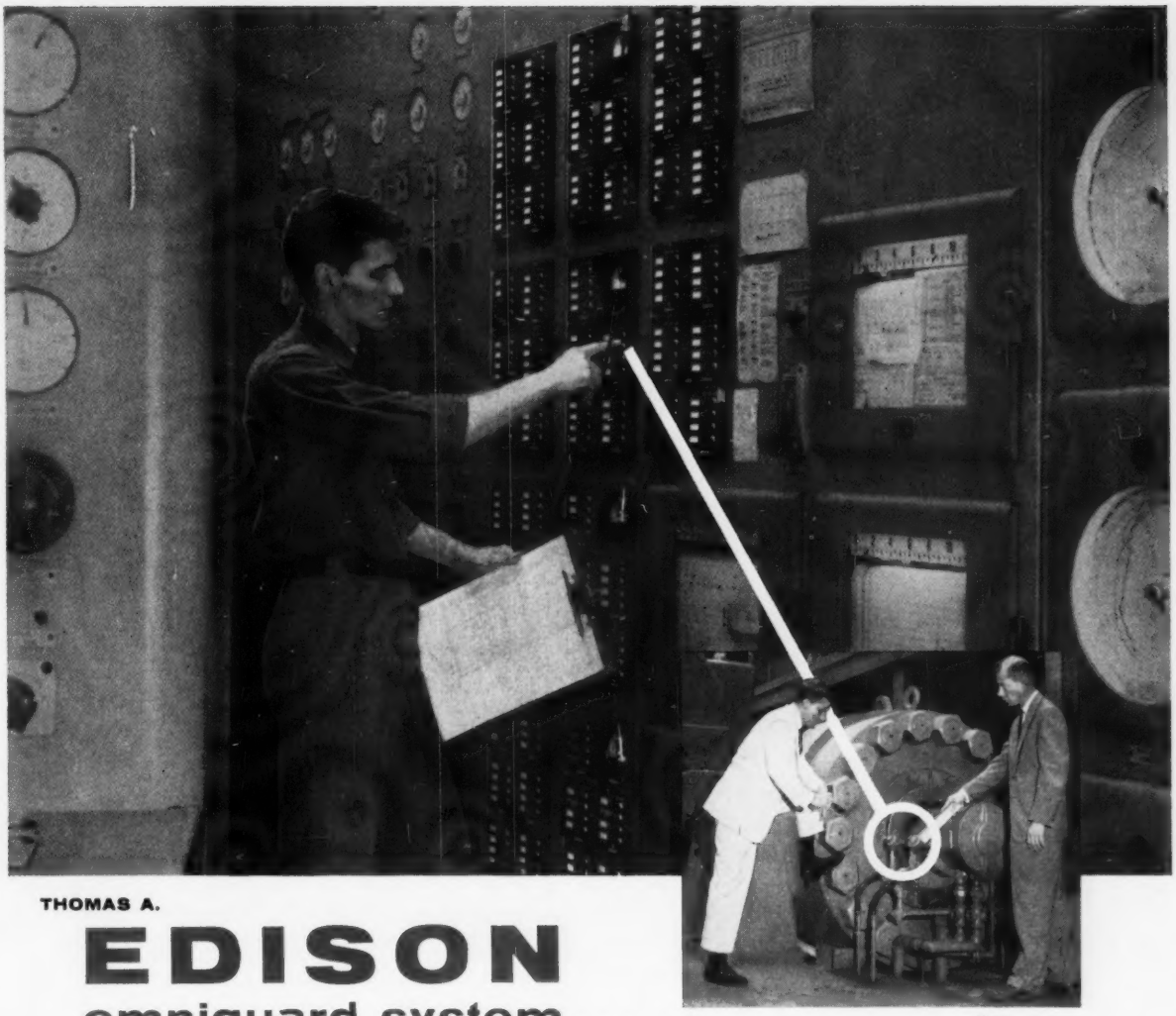
Equipped to use the 4200 hours of sunshine available in Central Arizona, it will work fundamentally to develop selective surfaces, solar engines, refrigerators and similar equipment. Among the areas planned for investigation: solar water heaters, solar-electric generation, h-t devices, solar furnaces.

Retirements

Frank Scholl, steam engineer at Wausau Paper Mills Co, after more than 50 years of service. **James A Cain,** Atlanta Div manager for A M Byers Co, after 18 years.

Recent moves

Pacific Sintered Metals Co now occupies new building, 8333 Hindry Ave, Los Angeles 45, Calif. **Electro-Mech Corp** moves into new plant at 500 Livingston St, Norwood, N. J.



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EDISON

omniguard system . . .

guards critical temperatures for Con Edison

Con Edison's power generating station in Astoria, Long Island, one of the largest of its kind in the world, supplies one-eighth of the power consumed by New York City's millions. An installation as vital as this naturally requires the utmost protection to insure efficient, uninterrupted operation—around the clock, around the calendar. And this is where Thomas A. Edison's OMNIGUARD system provides such an important contribution.

The bearings of Con Edison's auxiliary equipment, ranging from main boiler feed pumps to coal pulverizing mills, are monitored by Thomas A. Edison resistance temperature detectors which are connected to Omniguard monitors located in the main control room. If any one of the 200-plus bearings monitored begin to overheat, an alarm is sounded instantly, the trouble area is identified on the Omniguard panels, and prompt corrective action is taken. Thanks to Omniguard, trouble is detected *before* damage can be done—which not only increases bearing life but slashes Con Edison's over-all maintenance costs as well.

Any industry can enjoy the complete, continuous protection that Omniguard provides. For complete information on your particular requirements, call or write:

Thomas A. Edison Industries
INSTRUMENT DIVISION
43 LAKESIDE AVENUE, WEST ORANGE, N. J.

McGRAW EDISON

For more facts circle 322 on Reader Service card, p 103

Now proved in over

1,000

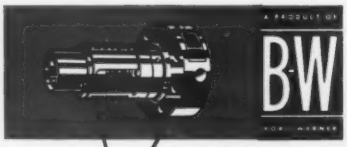
Installations

More than a thousand Borg-Warner Type "D" Mechanical Seals are installed for high pressure, high temperature applications, and are proving their worth with phenomenal performance records —many operating well over three years in continuous boiler feed pump service!

Especially designed for long, reliable duty under these conditions, the Type "D" Seal offers other important savings by eliminating or greatly reducing leakage of heat and treated feed water, and cutting expensive maintenance down-time. Further, no cold condensate injection is required for cooling.

Call or write for the new Borg-Warner Type "D" Seal Bulletin with complete engineering and installation information—there's no obligation!

Partial List of Type "D" Seal Users: *California Electric Power Co. • Toledo Edison Co. • Gulf States Utilities • Louisiana Power & Light Co. • Shell Oil Company • Union Electric Co. • Texas Company • Consolidated Edison, New York • Florida Power & Light • Owensboro Public Utilities • Union Oil Co., Wilmington • Tennessee Valley Authority • Baltimore Gas & Electric Co. • City of Los Angeles Dept. Water and Power • Detroit Edison Co. • Southern California Edison Co. •Hawaiian Electric Co. • Philadelphia Electric • Mississippi Power & Light • Houston Light and Power Co. • City of Burbank • City of Pasadena • Iowa Power & Light*



Borg-Warner Mechanical Seals

P.O. Box 2017, Terminal Annex, Los Angeles 54, California

For more facts circle 323 on Reader Service card, p 103

Bookshelf

Piping in steam-power plants and steam-using plants (Rohrleitungen in Dampfkraftwerken und dampfverbrauchenden Betrieben). *Commissioned by the Power Technique Subdivision of the Assn of German Engineers. Revised by Fr F Wiese with R Franzl, H Haferkampf, H Richter and E Schwenk. 288 pp, 221 illust, 46 charts, Dm 36.80. VDI-VERLAG GmbH, Dusseldorf 10, W Germany (available in German language only)*

Theoretical section covers hydraulic losses and piping-system design—strain and end reactions. Then practical sections include data on piping, fittings, supports, insulation, standard specifications and materials testing. Authors have described many typical piping systems in detail, based on practical experience. Recent developments in high-pressure high-temperature piping are covered.

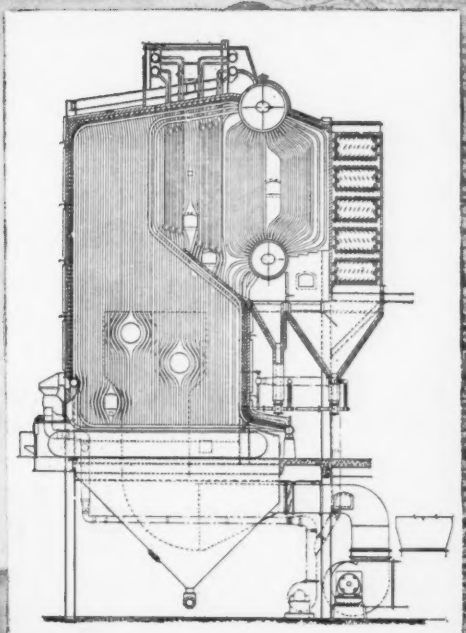
Nuclear Radiation Engineering. *By F W Hutchinson, Professor of Mechanical Engineering, University of Calif. 155 pp, illust, tables, cloth, $6.00. The Ronald Press Company, 15 E 26th Street, New York 10, N. Y.*

Book intends to give basic data for people working on the fringe of atomic activities rather than to those handling specific technical problems directly. It is a language primer enabling the administrator to communicate with the atomic physicist or nuclear engineer whom he must direct.

Greatest dollar volume in the nuclear field is represented by artificial radioisotopes produced in reactors rather than the reactors themselves. Nuclear-radiation engineering is a peripheral field used by many non-specialists.

Part 1 reviews methods used in establishing the structure of the atom. Part 2 reviews radiation phenomena in terms of atomic and nuclear structure. Part 3 covers radioactivity in terms of instruments, people and things; Part 4 has a dictionary of atomic and nuclear terms and phrases.

FUEL SAVINGS 16%



Longitudinal section of Union Type VO Steam Generator at City of Ames.

JOB: Includes delivering steam for a 12,650 KW Turbo-generator in Municipal Power Plant, City of Ames, Iowa.

STEAM GENERATOR: A Union Type VO Single-Pass (140,000 lbs./hr., 630 psi, 825° F). Fired by continuous ash discharge spreader stoker. Equipped with extended surface economizer for heat recovery. Selected for its adaptability to multi-fuel firing.

RESULTS: In continuous operation for six months, supplying total steam requirements, the Union VO was credited with fuel savings of 16%.

UNION

steam generators

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DIVISION OF RILEY STOKER CORP.

For more facts circle 324 on Reader Service card, p 103

By our method of reporting unemployment...

We're Giving The United States A Black Eye That Is Not Deserved

The way in which our unemployment is reported is giving the United States an undeserved black eye around the world. The broad concept of unemployment we use exaggerates the amount of unemployment in the United States as compared to most other countries. Our reporting system also falls short of presenting a balanced picture by concentrating on people who are idle, while neglecting jobs that are idle because people cannot be found to fill them. This editorial explains these defects and suggests improvements.

The *Monthly Bulletin of Statistics,* issued by the Statistical Office of the United Nations, has become a standard reference for international comparisons of economic performance, including employment and unemployment. Here, from the November, 1960 issue, is part of a table giving comparative figures on the rate of unemployment for the United States and a group of European countries:

	UNEMPLOYMENT RATE	
	Annual Average 1959	Jan.-June Average 1960
West Germany	2.4%	1.0%
Netherlands	1.8	1.4
Sweden	2.0	1.8
United Kingdom	2.3	1.9
United States	5.5	6.1

A Distorted Picture

If taken at face value the table clearly says that the United States is doing far worse in providing jobs for its citizens than the other countries whose unemployment records are listed.

But the figures are deceptive. They are made so, in part, by our government's use of a much broader concept of what constitutes unemployment than is used by most other countries.

Sweden provides a clear case in point. The table indicates that during 1959 Sweden had an unemployment rate of 2.0%, while the rate in the

United States was 5.5%. But a report from Sweden, published in the U.S. Department of Labor's *Labor Developments Abroad*, indicates that if they had used the same methods of calculating unemployment as we, the reported jobless rate in Sweden would have almost doubled. Thus a large portion of the gap between the unemployment rate in the United States and the unemployment rate in Sweden would have been eliminated.

Graduation To Unemployment

In general, countries listed in the table use registrations at public employment agencies as the basis for calculating their unemployment. Our Department of Labor, in making its sampling of unemployment, includes unregistered young people who are waiting for jobs or training opportunities as well as housewives who are looking for jobs in a general sort of way but who have not registered anywhere in search of them.

It used to be that graduation from college was regarded as a day for great celebration and rejoicing. But, because of the way the Labor Department does its counting of unemployment, it is now a day of sorrow. For unless our young people immediately rush off to jobs, they graduate into unemployment and swell our jobless figures.

While our government very expansively counts all the unemployed, there is no offsetting report on the number of jobs that are unfilled because no one qualified can be found to fill them. Currently there are many jobs in this category, and it is to be expected that there will be more as the technological revolution picks up momentum.

A properly balanced report on unemployment would include a record both of people who are idle, as conceived on some standard international basis, and jobs that are idle. A combination of the two sets of data would provide a much better indication of the economic health of a nation than unemployment alone.

The United Kingdom regularly collects figures on unfilled jobs as well as the number of unemployed. Thus it is not an impossible task to collect information on idle jobs. **For a fast moving economy, such as ours, the collection of statistics on unfilled jobs presents special difficulties. But this information is so important that Congress should see that it is added to our employment and unemployment records.**

A National Disservice

There is not the slightest inclination here to minimize the amount of unemployment in the United States at any time, or the crucial importance of doing everything possible to keep it at rock bottom. If the reporting of unemployment were simply for domestic consumption, it would be possible to make an appealing case for using a very broad conception of it. This is one way of underlining the importance of the problem.

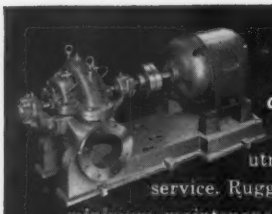
But when, as is the case, international comparisons of unemployment are treated as key gauges of the effectiveness of different economies, we do ourselves an important national disservice by using an exceptionally commodious concept of unemployment. American travelers abroad can testify that they are continuously being called upon to explain why the United States does such a relatively poor job in providing employment for its people. This is an unwise and unfair burden to impose upon the nation. **We make enough mistakes of economic commission and omission without issuing reports that distort our economic performance to our own discredit abroad.**

This message was prepared by my staff associates as part of our company-wide effort to report on major new developments in American business and industry. Permission is freely extended to newspapers, groups or individuals to quote or reprint all or part of the text.

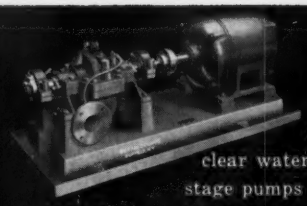
Donald C. McGraw

PRESIDENT

McGRAW-HILL PUBLISHING COMPANY

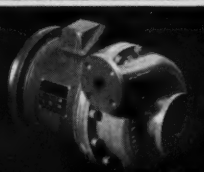


Clear Water Pumps—Double suction pumps designed for utmost efficiency in clear water service. Ruggedly built for dependability, minimum maintenance and down time. Send for Bulletin 955.



High Pressure Pumps—Ideal for boiler feed and other severe clear water service. These multi-stage pumps operate against heads to 1500 ft. Capacities to 900 gpm. For complete facts, write for Bulletin 980.

Close-Coupled Pumps—These efficient pumps save space, simplify installation. No need for shaft alignment. Vertical or horizontal models. Adjustable discharge angle. Write for Bulletin 975.

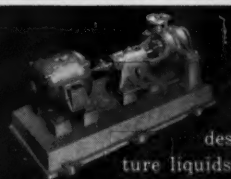


NEW! 'Buffalo' Hermetic Pumps—Quality pumps with special bearings for use where leakage would be dangerous or costly. Available in a broad range of materials of construction. Write for full details.

Non-Clogging Pumps—Move high consistency liquids dependably and efficiently. Minimize wear and wedging. Inspection simplified by diagonally split shell. Rubber-lined models for moving abrasive or corrosive liquids. Send for Bulletin 953.

Chemical Liquid Pumps—Specially designed for moving most corrosive abrasive or high consistency liquids. Your choice of many types in a variety of trim. Will withstand punishing conditions. Write for Bulletin 976.

GPL*



Heat Transfer Pumps—These special 'Buffalo' Pumps are designed to handle high temperature liquids. Job-engineered construction includes required alloys, water-cooled bearings and proper packings. Single suction, solid shell design gives peak efficiency. Write for complete details.

*** True long-range pump economy depends on GPL (Gallons Per Lifetime)...pumped day-in-and-day-out with a minimum of down-time and maintenance costs. This is the kind of long-lived reliability built into every 'Buffalo' Pump. It is the most important result of top quality design and construction.**

'Buffalo' offers a complete line of centrifugal pumps featuring parts interchangeability and low maintenance. Whatever your liquid moving needs, chances are there's a 'Buffalo' Pump to fit it perfectly. And your 'Buffalo' resident engineer is the man to recommend it. Contact him, or write us direct.

"Buffalo" PUMPS

BUFFALO PUMPS DIVISION

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'Buffalo' Air Handling Equipment to move, heat, cool, dehumidify and clean air and other gases.

'Buffalo' Machine Tools to drill, punch, shear, bend, slit, notch and cope for production or plant maintenance.

'Buffalo' Centrifugal Pumps to handle most liquids and slurries under a variety of conditions.

Squier Machinery to process sugar cane, coffee and rice. Special processing machinery for chemicals.

Wolverine supplies condenser tube for Enrico Fermi Atomic Power Plant

The increasing extent of the heat transfer services provided American industry by Wolverine Tube, Division of Calumet & Hecla, Inc., is demonstrated by the use of Wolverine prime surface condenser tube in the Enrico Fermi Atomic Power Plant near Monroe, Michigan. The plant is a combined project of The Detroit Edison Company and the Power Reactor Development Company.

For this critically important installation, Wolverine Tube has supplied more than 500,000 feet of prime surface admiralty condenser tube for the main steam condenser.

This tubing, as is all Wolverine condenser tube, was "coupon tested" during manufacturing. In this program, samples are clipped from the end of each length of condenser tube. Mechanical expansion tests of each sample assures that the tube will withstand flaring or rolling-in operations without cracking or splitting.

Wolverine Tube is extremely proud that the high quality of its condenser tube products is helping bring the wonders of atomic power closer to daily reality.

If your company is engaged in heat transfer, it is highly probable that Wolverine Tube can help you do a better job more economically. Our consultation services are available to you without obligation. Let us provide additional information on our services and facilities—write today.

SEE NEXT PAGE FOR WAY TO INCREASE PREHEATER EFFICIENCY

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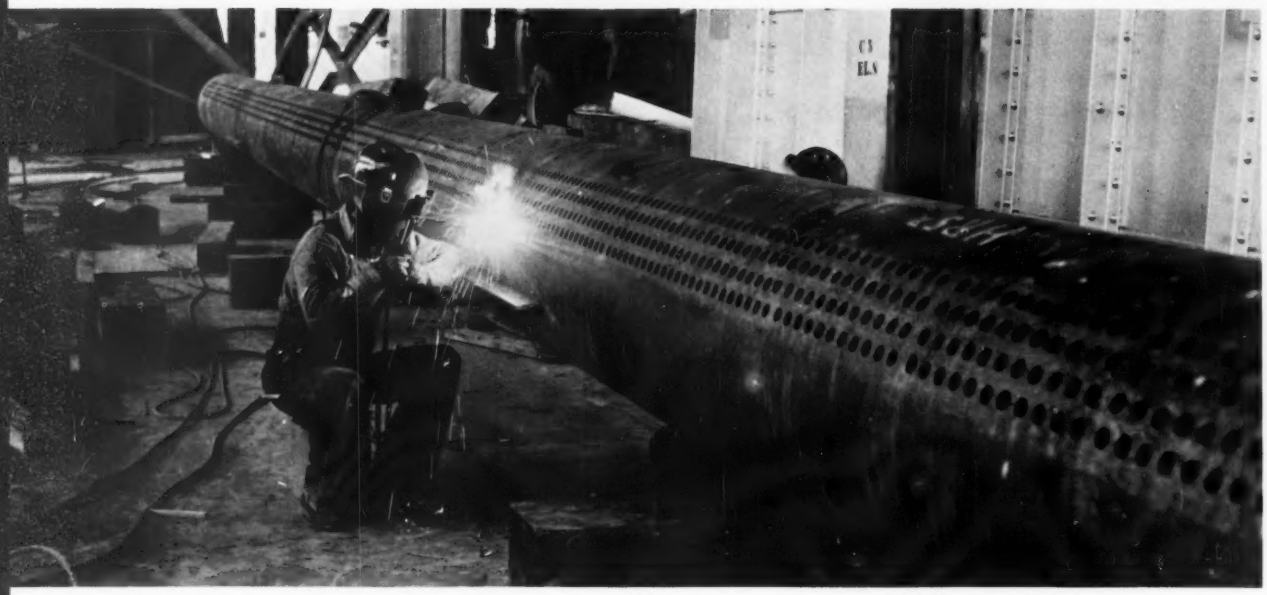
Wolverine Trufin® Type L/C helps Wisconsin Electric increase power plant efficiency



Air preheaters—tubed with integrally finned Wolverine Trufin Type L/C heat exchanger tubes—are making substantial contributions to operating efficiency at Wisconsin Electric Power Company's new, 275,000 K.W. power plant, Oak Creek Unit #5, near Milwaukee, Wisconsin.

Designed to handle 102,600,000 BTU's per hour heat duty, the preheaters utilize bled turbine steam inside the tubes to preheat the combustion air for the 1,780,000 1b/hr steam boiler.

Trufin Type L/C is efficient because its extended outer surface of integral aluminum fins increases, tremendously, the amount of heat transfer surface available to preheat the inrushing air. In addition, its integral fins are actually squeezed from the tube wall and are unaffected by the varying temperatures, vibration and thermal shock, inherent to this type of unit.

In this particular application, more than 280,000 square feet of total surface was used. The tubing, Type L/C, varies in length from 13 to 16 feet. The outer tubing of aluminum alloy 6063 is mechanically bonded to an inner liner of aluminum alloy 6061, Temper T-4. There are 11 fins to the inch. If necessary, the inner liner could have been composed of any desired metal or alloy.

This is but another example of how Wolverine Trufin serves American industry. If you have a heat transfer application, Wolverine Tube, Division of Calumet & Hecla, Inc., can help you do a better job, more economically. For complete information just write, wire or call.

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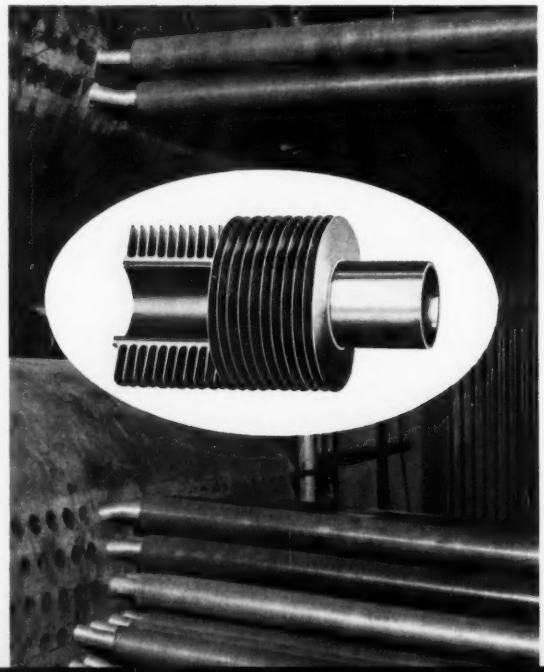
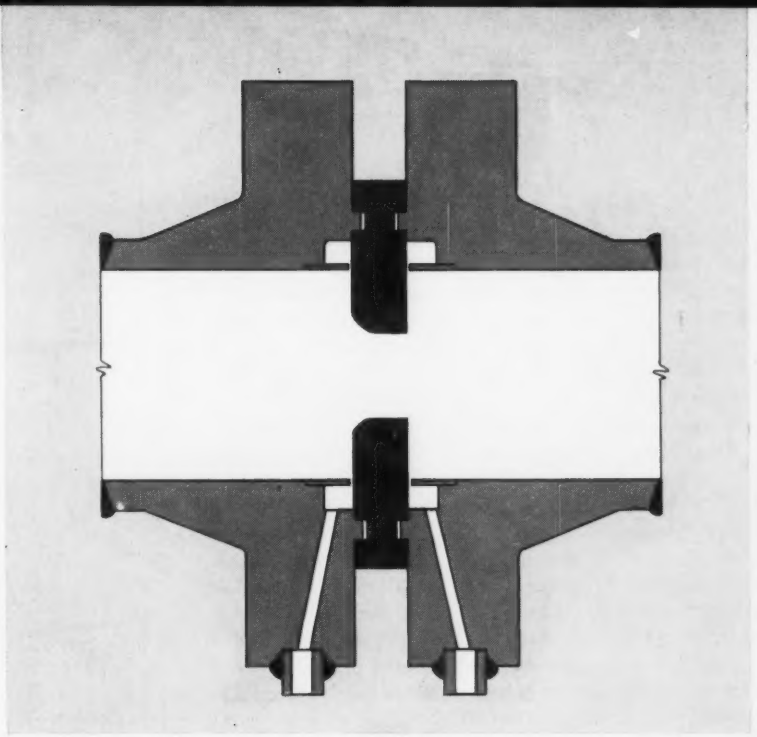


STEVE ELONKA
Associate Editor in Charge



Control of today's steam generators hinges on accurate, dependable measurement of many flows. Here's a rundown of operation-proved techniques used in several new plants where we were able to develop modern . . .

Flowmetering for high accuracy at low cost

By R G TOMKINS
Instrument Engineer
O H HEDRICH
Mechanical Consultant
The Fluor Corporation, Ltd

Modern steam-generation units boast a response and flexibility of operation to match today's need to handle sudden load changes at high efficiency. The heart of these new units lies in the improved control systems which permit us to take full advantage of response and flexibility. Today, as in the past, steam- and feedwater-flow measurement and control are major factors in operation of a complete cycle. Accurate measurement of these flows should receive a great deal of attention in the design of a power station.

In large central stations we find it increasingly difficult and costly to design the main steam piping to obtain suitable meter runs—particularly true where we plan multiple steam leads to the turbine. This problem, combined with the undesirable pressure loss and cost of flow nozzles in the steam lines, forced an investigation of alternate means of flow measurement. Our investigations and other development work proved the usefulness of steam-flow criteria and the advantages of the International Standards Assn flow nozzle shown above for accurate, dependable measurements.

With solving your flow-measurement requirements as a goal, let's look at some problems of steam-flow metering and the characteristics of boiler-turbine control which permit a new approach to flow measurements. continued

Accurate steam and water flows must be obtained for both the usual 3-element feedwater control and combustion control based on pressure. Steam flows are more difficult to meter accurately since they are subject to more variations in measurement environment. To better understand this, study the pressure-load curves at right. Combustion controls may operate with constant drum pressure, top, controlled sliding throttle pressure, middle, or controlled constant throttle pressure, bottom.

Drooping throttle pressure has several advantages. Thermal-flywheel effect of boiler permits instantaneous load acceptance without dropping the throttle pressure below design value. This same effect permits sudden load drop without undesirable safety-valve operation. And feedwater-regulator pressure drop is minimized where constant-speed feed pumps are used, bottom curve.

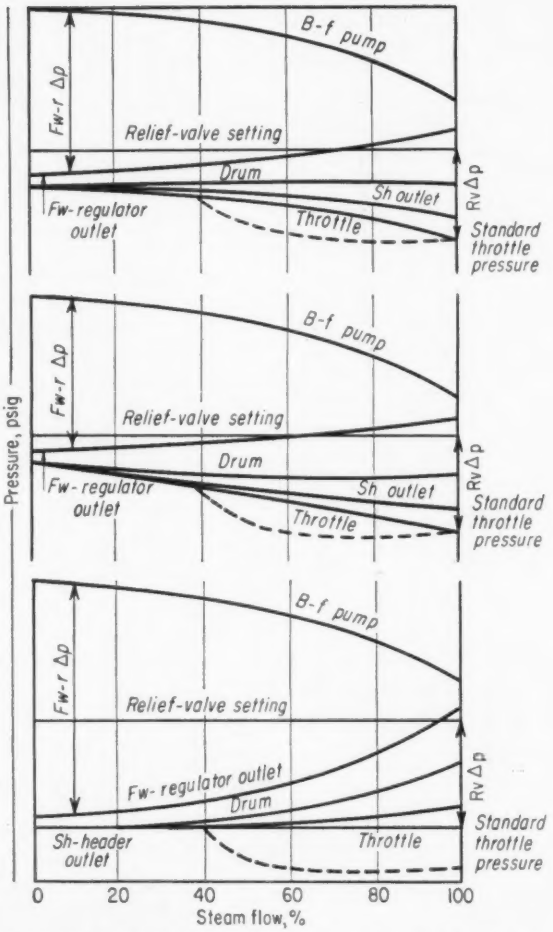
Relating these control characteristics to measurement, we see that variable steam-line pressure, particularly during upsets, introduces errors in steam-flow readings. To get away from these a nonvolumetric flowmeter is needed.

Research indicated that absolute pressure downstream of the first stage of a turbine was linear with flow. Experiments at the Broadway plant of the City of Pasadena proved this, and it was decided to use first-stage turbine pressure as an index of steam flow for control functions at California Electric Power Company's San Bernardino Station. Output of the first-stage-turbine pressure transmitter was characterized by a calibration relay to give a reading of true flow as determined from the feedwater-flow measurement. One advantage of this flow-measurement arrangement: with only one meter involved, inevitable problem of registering steam- and feedwater-flow readings from separate instruments is avoided.

To obtain accurate feedwater-flow measurements we decided to use a calibrated flow run. This consisted of a bored upstream and downstream section with large tongue-and-groove flanges at each end. A standard orifice plate clamped between the middle flanges. A standard mercury flowmeter with a 600-in. H_2O differential was selected for accurate measurements over a wide range.

Finished flowmeter run complete with orifice plate was sent to the California Institute of Technology for calibration under the direction of the late Dr Robert Knapp. Dr Knapp calibrated the standard orifice plate in the specially machined run. Although the upstream meter run of over 30 pipe diameters exceeded requirement for good flowmetering practice, Dr Knapp was surprised to find the *K* factor or flow coefficient shifted about 7% when an ordinary elbow was used in place of the vaned elbow at the entrance to the approach run. It was evident that hydraulic disturbances entering the horizontal run did not die out before reaching the orifice plate.

Straightening vanes were installed in the meter run—calibrations with and without the vaned elbow were identical. Attempting to find some means of accurate flow measurement without the cost and added pressure loss of straightening vanes, Dr Knapp conducted a series of experiments with conventional orifices.

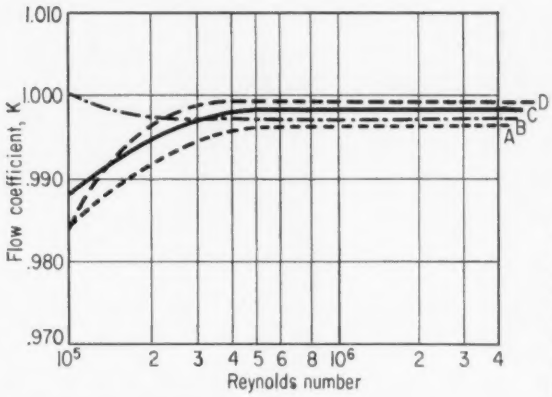


PRESSURE CURVES show effect of holding drum or throttle pressure. Sudden loads drop turbine throttle pressure to dotted lines

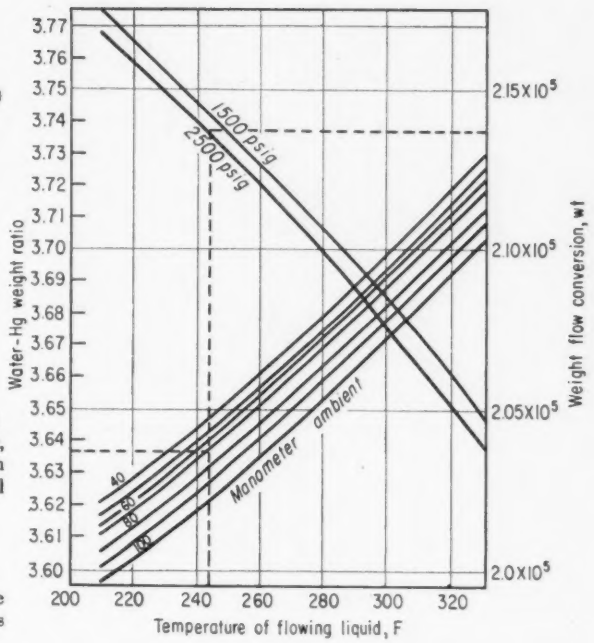
An external piezometer ring was attached to each set of six pressure taps like a wheel with six spokes. Calibration tests were made on the external piezometer installation using (1) a vaned elbow (2) a plain elbow (3) a long-radius bend in the approach piping. Using the external piezometer ring, meter coefficient with all three approach conformations proved the same.

Dr Knapp then turned his attention to the International Standards Assn or German Standard flow nozzle, which has an internal piezometer ring. This nozzle is described in at least two ASME publications: p 26 of "Flow measurement," 1940, p 34 of "Fluid meters: their theory and application," 1937.

This flow nozzle has a special contour, with nozzle radii, plate thickness and other dimensions defined in terms of nozzle-throat diameter. Stainless-steel rings before and after the nozzle form internal piezometer rings, also serve as wear rings to maintain a clean sharp edge in service.



CALIBRATION CURVES for different nozzles show effect of careful machining and placement in line. Nozzle *A* had incorrect contour, nozzle *B* was poorly machined, had reverse curve. Nozzle *A* with poor approach gave curve *C*. Nozzle *D* was well made and placed



FIELD CALCULATIONS are simplified by preplotting part of nozzle flow formula related to water and manometer-fluid weight ratios

Nozzle design was modified for ease of machining and for installation between close-tolerance large tongue-and-groove flanges with the groove modified to allow for a metal-to-metal contact and controlled laminated-metallic-gasket compression.

Nozzle assembly is in use at both the City of Glendale Unit No. 4 and the City of Burbank, Olive St plant. Both assemblies were calibrated at the California Institute of Technology under the direction of Dr Vito A Vanoni.

Dr Vanoni's calibration included a check of nozzle contour and his findings are reflected in the calibration curves above. The City of Glendale nozzle was well machined and resulting calibration curve *D* was smooth. City of Burbank's stainless-steel nozzle was found to be a little out of contour, resulting in curve *A*. Carbon-steel nozzle for the City of Burbank, to be used for temporary startup, was not too carefully machined. Its calibration, *B*, shows a reversed curve we attribute to machining.

Dr Vanoni also calibrated the stainless-steel nozzle for the City of Burbank without the vaned elbow in the approach piping, *C*. While the two curves differ, the change is in the third decimal place—about 2/10%.

When boiler acceptance tests were performed at the Olive St plant of the City of Burbank, a high-pressure manometer was used with the ISA nozzle to measure feedwater flow. Readings were compared with the feedwater-flow recorder and feedwater integrator; results were well within accepted limits for field data.

Field tests using these nozzles may be simplified by graphic solution of some flow calculations. The fundamental flow equation for an orifice meter may be revised:

$$W = KA_2E\sqrt{\frac{2g}{12}}\quad\sqrt{\frac{W_{Hg}-W_r}{W_p}}\quad\sqrt{\text{in. Hg } W_t}$$

Where: W = lb per hr; K = flow coefficient; A_2 = nozzle area, sq ft; E = thermal-expansion coefficient of flow nozzle; g = gravity acceleration; W_{Hg} = mercury's specific weight, lb per cu ft; W_r = manometer water, lb per cu ft; W_p = water flowing, lb per cu ft; in. Hg = differential pressure read in inches of mercury under water; W_t = 3600 ÷ specific volume of flowing fluid.

Breaking the equation into the four components above, we can calculate the first portion prior to tests. Second radical may be solved from graph, above right. A table or curve of differential square roots also helps. The final term may be preplotted as it appears superimposed on our previous graph of water-Hg weight ratio. Armed with these graphs and a slide rule, a field engineer can make very-rapid field-check calculations when running boiler tests.

Summing up the advantages derived from these advances in steam and feedwater metering:

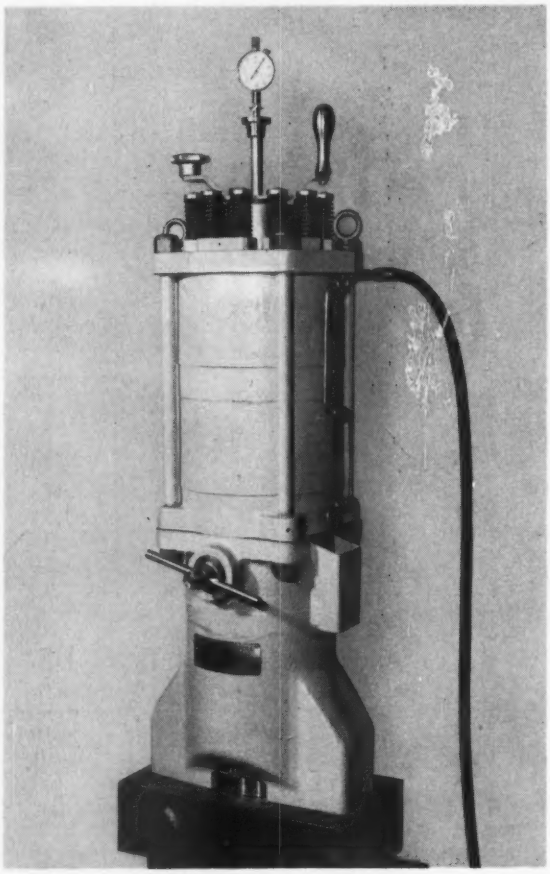
(1) Substituting first-stage turbine pressure for steam flowmeter reading results in a much lower first cost, simpler installation.

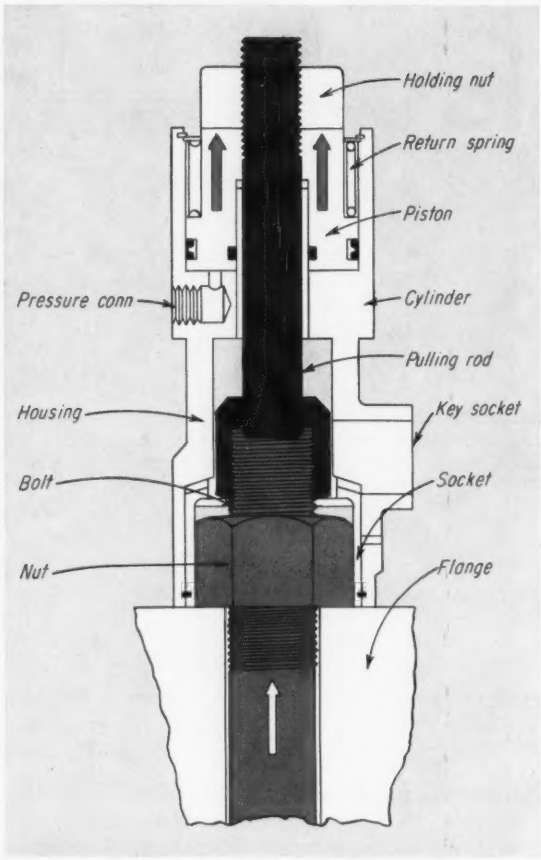
(2) Easily removable feedwater-flowmeter run may be lab recalibrated during any plant overhaul.

(3) Nozzle plate is easily, inexpensively replaced.

(4) Integral piezometer rings average out pressure upsets and effectively reduce the straight-run requirements, result in a cost saving and consistent readings.

By STEVE ELONKA, Associate Editor





HYDRAULIC TENSIONER is positioned, then pulling rod is screwed down over the portion of the bolt extending beyond the nut. Rod must engage a length equaling at least ¾ bolt's diameter. Bolt stretches when hydraulic-actuated piston applies pressure

How about prestressing your bolts?

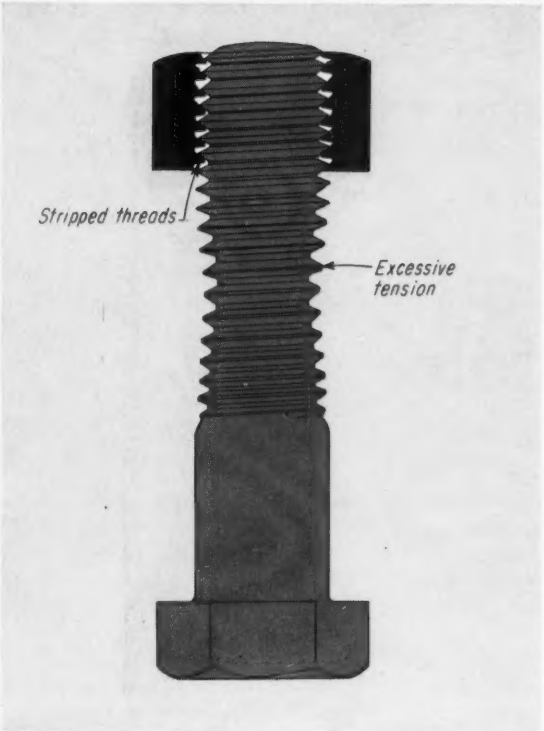
Tightening a nut seems like a simple process. But do you realize that only about 10% of the beef put onto the end of a wrench actually goes into tightening the nut? What happens to the other 90% of muscular effort involved?

Torque is a rotation-producing twisting—the turning moment of a tangential effort. Lab studies show that around 50% of the torque we apply to a nut goes into overcoming friction under the bolt head. Don't forget that this is a sliding contact; because of the wedging action of the threads as they stretch the bolt, these surfaces are under extremely high pressure. If rubbing surfaces are rough or dry and poorly lubricated, they'll absorb even more torque. Then, 40% of the effort is spent overcoming friction in the threads—this too depends on finish and lubrication. Now only 10% of the applied torque is left to create tension in the bolt itself.

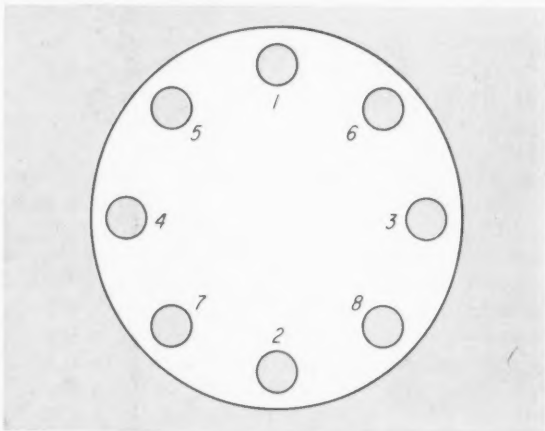
Of course, the only condition we're interested in producing when tightening a nut is bolt tension. A bolt acts like a rubber band. It must be under constant tension to contain the pressure within a flanged vessel, especially during pressure fluctuations.

Theoretically, if a bolt and its flange assembly had no give whatever, tightening the nuts by hand until the flange surfaces made contact would be sufficient. But because all metals are elastic, even when hardened, the bolt must be stretched enough initially to contain the medium being sealed at its highest pressure.

Studies indicate that type of lubricant used on bolt and nut threads has some influence on the torque-tension relationship—but not too much. Many experts feel this is probably because the pressures built up between contact surfaces are so high few lubes can have much effect. But experiments also show that when bolts and nuts are assembled perfectly dry, the threads often seize before the



OVERTIGHTENING the bolt-and-nut assembly tends to weaken the bolt. Nut threads may be partially stripped and distorted



SEQUENCE for tightening nuts by hand or using one tensioner. It may be better to use two or more tensioners simultaneously

correct tension is reached. In such cases the torque can be extremely high even though the bolt is not tight enough. And torquing dry bolts often twists them in two when only about half the needed tension is reached.

But suppose we could first stretch the *bolt* to the tension needed for a given service, then screw the nut down by hand until it made contact? No torque would be wasted—for none would be used. Yet we'd have the proper tension. From all this it would seem the best way to put bolts to work is to prestress them—and it probably is.

Several bolt tensioners on the market will do just that—tension bolts without torquing. As the sketch at left shows, the pulling rod or bolt-stretching part of the instrument is screwed down over the portion of the bolt extending through nut. Rod engages a length of threaded section equaling at least ¾ of the bolt diameter of effective threads. When a hydraulic-actuated piston applies pressure against the holding nut, result is tension in both the pulling rod and the bolt. Compression reaction to this force is relayed to the flange by the supporting housing. This lifts the nut away from the flange.

Operator then uses a key extending from the tensioner's side to rotate the nut socket until it seats on the flange. Soon as hydraulic pressure is released, load is transferred to the stud-and-nut assembly.

To offset the loss occurring when the nut takes the load from the tensioner, bolt must be preloaded to about 20% extra load. For uniform closing, especially of critical flanges, best method uses three or more instruments simultaneously to apply even tension. Then you don't have to worry about the bolt sequence usually followed when torquing with a wrench, bottom sketch, this page. The tensioners create the pulling force, and they're designed to accommodate the necessary 20% extra load.

Controlled bolt loading means exerting a predetermined load on the stud or bolt and reading the tension on a gage, according to Biach Industries, Inc, Cranford, N. J. tensioner makers. A preloaded stud-and-nut assembly is free of stud seizure due to galling because there is no relative motion between the mating parts. Controlled preloading is said to be faster than bolt heaters and more accurate than torquing devices. Commercial accuracies of 10% can be expected between bolts. And where necessary, a tensioner can produce much finer tolerances.

At present, a prime service for tensioners is closing nuclear-reactor housings and other critical equipment. Units can be designed with special features such as spherical washers to assure a direct-line pull where the vertical alignment of the stud may not be too accurate or flange rotation creates a bending load. The large tensioners have weight-carrying centering pins for easier mounting. Remote-control operating features are available for closing operations in contaminated areas. Tensioners are designed to fit all ranges of bolts and bolt circles, meet any loading, whether it's vertical or horizontal.

Support housing of the tensioner and flange of the vessel usually have enough area so the reactive force between the two surfaces does not exceed 20,000 psi. These loads can be greatly reduced for glass, ceramics, carbon and other brittle materials. Contour housings can be provided where the bearing area of the flange creates too high a loading between support housing and flange.

Next month's Operators' notebook *will discuss bolt stretch, deal with the various types of bolts.*

When head pressure goes up—so does operating cost. Keep both under control by...

Purging your refrigeration system

The knowledge is common among refrigeration engineers and system operators that air in the condenser causes a rise in head pressure. But what they're apt to overlook is *why* air's presence increases head pressure and *how*, in many ways, this increase can add significantly to overall costs.

First of all, let's briefly review air's effect on condenser performance, then see how this adverse effect makes itself felt throughout the system. When air molecules spread themselves across the condenser's heat-transfer surfaces it becomes extremely difficult for the refrigerant-gas molecules to reach these surfaces to give up their heat energy. Thus air's presence has the effect of reducing amount of heat-transfer surface available to the refrigerant gas. The only way to offset this "smaller-condenser" effect is by increasing temperature—and pressure —of the refrigerant gas so that total amount discharged by the compressor will be condensed.

As discharge pressure rises, a number of effects are apt to follow. One, certainly, is an increase in power input. Accepted rule: for each 4-lb increase in head pressure—due to air or other noncondensable gases in a refrigeration system — compressor power costs go up 2% and compressor capacity drops 1%. This 4-2-1 formula for increased power cost and decreased capacity applies to all common refrigerants, under wide differences in suction and head pressure. It's obvious that such power-cost increase means a profit decrease somewhere along the line. Too, decrease in compressor capacity means operating the unit more hours to get the same refrigeration effect. In many cases, other losses caused by lowered compressor capacity may add up to far more than the extra cost involved in operating the compressor against the higher head pressure.

Added cost factors: Cooling-water use increases and heat-transfer efficiency drops off. Using more cooling water may mean much or little to the individual plant, depending upon its location, pumping system, water source and cost, recovery factor and so on. However, it's a safe bet that unnecessary water used in any plant ups operating costs to some degree.

Excess head pressure takes its toll from the compressor itself. Bearings (this applies to the driving motor also) are subjected to greater loading. Higher temperatures accompanying increased discharge pressures tend to shorten valve life, promote lubricating-oil breakdown. And gasket failure often goes hand-in-hand with excessive head pressure.

From a practical standpoint, it's impossible to keep air and other noncondensable gases from sneaking into the majority of refrigeration systems. If system operates with suction pressure below atmospheric, air leakage is most likely through valve packing and compressor seals. But, whether suction pressure is above or below atmospheric, air will find additional ways of getting into the system: (1) when system is opened for cleaning or repair (2) when you're making or breaking hose connections to discharge refrigerated cars or trucks (3) when you're adding compressor lube oil (4) by refrigerant or lube-oil breakdown (5) from impurities in the refrigerant itself.

A sure sign that air or other noncondensables have crept into your system is a discharge-pressure-gage reading higher than normal for any given refrigerant temperature leaving the compressor. Table 1 lists temperature-pressure relationships for three widely-used refrigerants: saturated ammonia, Freon 12 and Freon 22.

Example: If ammonia temperature leaving the compressor is 84 F, theoretical condenser pressure is 149 psig. If the discharge-pressure gage reads 169 psi, 20-psi excess pressure is increasing power costs by 10%.

Liquid temperatures are easy to read if the liquid line from the condenser is equipped with a mercury well. Without the well, reasonably accurate readings can be obtained by taping the bulb of an immersion thermometer to the liquid line. Cover the bulb with about 1-in. of asphalt sealing compound or similar protective substance, then insulate with suitably heavy cloth. After a lapse of 3 or 4 minutes it should be possible to take a reading accurate to within ½ to ¾ of a degree.

Remember, however, that air and other noncondensables are not the only causes of excessive condenser pressure. If condenser simply isn't big enough for the job, or if it's per-

mitted to operate with fouled or scaled tubes, head pressure will go up. But in most cases air is likely to be the culprit and must be purged before head pressure can be reduced to the proper level.

Purging, like everything else, can be done in more than one way. To be effective it must be done slowly, giving air molecules time to migrate to purge connections.

It's possible, of course, to purge manually, though it isn't practical from an expense standpoint except on very small units. Table 2, for instance, shows that manually purging 1 cu ft of air from an ammonia system at 90 F and only 4-psi excess pressure due to air wastes 51 cu ft of ammonia. Or, from Table 3, manually purging 1 cu ft of air from an F-12 system at similar temperature and excess-pressure conditions allows 32.3 cu ft of Freon to escape.

At best, then, manual purging either takes a lot of time or not all the air is removed. In the latter case, adverse effects of air in the condenser continue, though at reduced rate. Summing up the case against manual purging: (1) It wastes refrigerant. (2) It takes a man's time which might be invested to better advantage elsewhere. (3) Air is almost never completely eliminated. (4) Released refrigerant gas may be disagreeable, could be dangerous. (5) Purging may be postponed or ignored because of time and trouble involved in doing it.

Automatic purging, then, appears to be the logical way of handling the problem. Let's refer again to Table 2 and contrast the 4216 cu ft of ammonia lost by manual purging at 80 F and 4-psi excess head pressure due to air, with the 0.25 cu ft of refrigerant lost at a temperature of 0 F in an automatic purger with head pressure of 157 psia. Under these conditions automatic purging is 42.6/0.25, or 170 times, as efficient from a refrigerant-loss standpoint. Checking Table 3, we note that automatic purging of a Freon-12 system with same temperature and excess head pressure is 26.3/0.31, or 84.8 times, as efficient as manual purging.

Automatic system purging, commonly referred to as "refrigerated" purging, is applicable to practically any system at relatively low cost. It involves nothing more than installing commercially available, simple, dependable refrigerated devices. These automatically and completely separate air by condensing the refrigerant gas. Then they release the air to the atmosphere. Advantages derived from these devices, which require almost zero maintenance, are obvious in view of today's constantly rising operating costs and dependability requirements.

1—Too-high gage reading means air in the system

If temperature, F, is:	Gage pressure should be: Ammonia	Freon 12	Freon 22
44	64.7	40.70	75.04
46	67.9	42.65	78.18
48	71.1	44.65	81.40
50	74.5	46.69	84.70
52	78.0	48.79	88.10
54	81.5	50.93	91.5
56	85.2	53.14	95.1
58	89.0	55.40	98.8
60	92.9	57.71	102.5
62	96.9	60.07	106.3
64	101.0	62.50	110.2
66	105.3	64.97	114.2
68	109.6	67.54	118.3
70	114.1	70.12	122.5
72	118.7	72.80	126.8
74	123.4	75.50	131.2
76	128.3	78.30	135.7
78	133.2	81.15	140.3
80	138.3	84.06	145.0
82	143.6	87.00	149.8
84	149.0	90.1	154.7
86	154.5	93.2	159.8
88	160.1	96.4	164.9
90	165.9	99.6	170.1
92	171.9	103.0	175.4
94	178.0	106.3	180.9
96	184.2	109.8	186.5
98	190.6	113.3	192.1
100	197.2	116.9	197.9
102	203.9	120.6	203.8
104	210.7	124.3	209.9
106	217.8	128.1	216.0
108	225.0	132.1	222.3
110	232.3	136.0	228.7

2—Ammonia lost through manual purging

Temp, F	NH_3, psia	Air, psia	Total psia	Cu ft lost per cu ft air purged
90	180.6	4	184.6	51.0
		8	188.6	25.5
		14.7	195.3	13.9
80	153.0	4	157	42.6
		8	161	21.3
		14.7	167.7	11.6
70	128.8	4	132.8	35.3
		8	136.8	17.7
		14.7	143.5	9.6
30	59.74	97.26	157	0.64
20	48.21	108.79	157	0.45
10	38.51	118.49	157	0.33
0	30.42	126.58	157	0.25
—10	23.74	133.26	157	0.18
—20	18.30	138.70	157	0.13

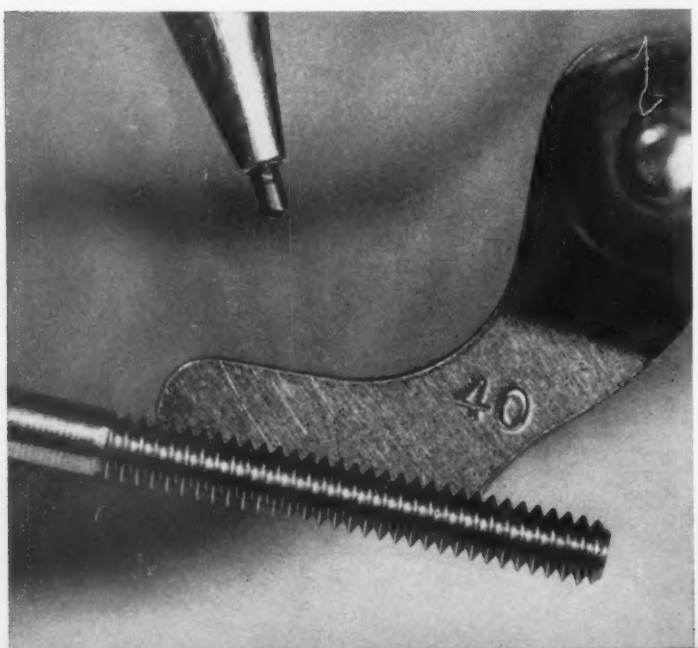
3—Freon 12 lost through manual purging

Freon, psia	Air, psia	Total psia	Cu ft lost per cu ft air purged
114.3	4	118.3	32.3
	8	122.3	16.1
	14.7	129	8.8
98.76	4	102.76	26.3
	8	106.76	13.1
	14.7	113.46	7.15
84.82	4	88.82	23.2
	8	92.82	11.6
	14.7	99.52	6.3
43.16	59.60	102.76	0.77
35.75	67.01	102.76	0.55
29.35	73.41	102.76	0.41
23.87	78.89	102.76	0.31
19.20	83.56	102.76	0.23
15.28	87.48	102.76	0.18

Do you know these screw-thread fundamentals?

By EVAN W BAKER
General Electric Co

ACME THREADS are checked by author Baker, above. This type is used where great strength is required, in this case on the vertical screws of a large tensile-testing machine. The tiny size of the 4-40 screw, lower photo, is shown by comparison with the tip of a mechanical pencil held directly above the thread gage



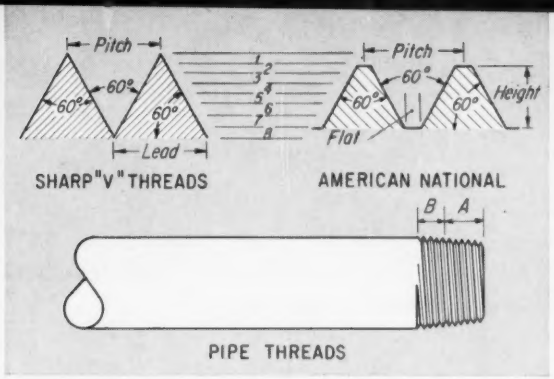
Most of us work with screw threads daily, yet few of us take the trouble to know the bare fundamentals of this complex subject. In a series of three articles, I shall cover enough high spots to help you obtain the best possible service when working with the more widely used threads.

Common thread forms are those in the sketch and table at right. Let's analyze them for similarity. All are 60-deg threads. The thread groove has an included angle of 60 deg; sides of the thread grooves also form a 60-deg angle with the center line of the screw. These threads differ in size, pitch, lead and fit, but in general you might say they have the same basic form.

Pipe threads are tapered so joints will make up tight and leakproof if assembled with a joint compound. Because of this taper the threads in area *B* of sketch are imperfect, while those in area *A* are perfect, having full depth and form.

Pitch of a thread is the distance between the crest of one thread and the crest of the next, measured lengthwise along the threaded part. Actually the thread is a continuous helix, but for simplicity each crest may be considered separately. Pitch is usually stated in threads per in.; for example, "8-pitch" means 8 threads per in. Top drawings at right show cross-sectional views of sharp "V" thread and American National Form Thread and indicate common terminology.

Lead of a thread is the distance the screw or nut advances in one turn, above, left in sketch. For a single thread, lead is the same as pitch. But where you have a multiple thread—



COMPARISON of three most common types of threads. Pipe threads in area *B* are imperfect; those in *A* have full depth, form

Common thread forms

NF—American National Fine Thread
NC—American National Coarse Thread
NPT—American National Taper Pipe Thread
UNF—Unified National Fine Thread (American, Canadian and British interchangeability)
UNC—Unified National Coarse Thread (American, Canadian and British interchangeability)

two, three or four single threads cut side by side—the lead is accordingly two, three or four times the pitch. Reason: rapid movement along the threaded portion is often more desirable than the gripping power of a single thread.

Truncation. The common "V" thread has a sharp crest and root, usually undesirable features. This knife-like edge is dangerous to handle and adds little strength to the thread. And because the sharp root cuts deeper into the bolt's body it reduces effective diameter and strength. The American National Form Thread takes care of this difficulty; it is truncated or flattened one-eighth of its cross-sectional height (or depth of groove) at both crest and root, producing the "flats" shown in sketch, above, right. This eliminates the disadvantages of the sharp crest and root.

Thread designation: size is always given first, followed by the number of threads per in. The thread series is then given, and finally the fit. Example is a right-hand ¼-in. National Coarse thread, 20 threads per in., with a Class-2 fit. This is designated ¼-in.-20 NC-2.

If the thread is of the Unified Series (interchangeable in American, British and Canadian terminology) it is designated ¼-in.-20 UNC-2A. Letter *U* represents "Unified." Last letter refers to the class of fit; an *A* suffix indicates an external fit in the Unified Standards, *B* suffix indicates an internal fit.

Examples of a specific thread under the American National designation: ¼-in.-20 AN-2. Here the *AN* applies to both the bolt and the nut. Same size bolt and nut under the Unified designation would be noted as Bolt ¼-in.-20 UNC-2A; Nut ¼-in.-20 UNC-2B.

Fits. These, briefly, are the American National classes of fit: Class 1, free assembly; Class 2, common bolts, nuts and machine screws; Class 3, best interchangeable fit; Class 4, snug fit requiring selective assembly; Class 5, wrench-tight fit.

The Unified class of fit: Class 1A (bolt), free assembly; Class 1B (nut), free assembly; Class 2A (bolt), common bolts and machine screws; Class 2B (nut), common nuts; Class 3A (bolt), close, accurate fit; Class 3B (nut), close, accurate fit.

By exchanging different classes of bolt fits, designated *A*, which is the external thread under the Unified System, and nut fits, internal-thread *B*, you can obtain a wide range of combinations.

Unless otherwise stated, a thread is always assumed to be right-hand. If it should be left-hand, letters *LH* follow the fit: ¼-in.-20 NC-2-LH.

Class 2 (or 2A bolt and 2B nut) tolerances are such that finger-free assembly is possible without the trouble of matching or selecting the mating parts. For most jobs this type of fit is accurate enough and, of course, easy to assemble.

Measurement. Measuring fine-pitch threads isn't always easy. A screw-pitch gage is usually used for this. It's just a case of matching a leaf of the gage with the thread. At times you may have to use a rule or scale to find the thread pitch. There are several methods, but here's an easy one that usually works well:

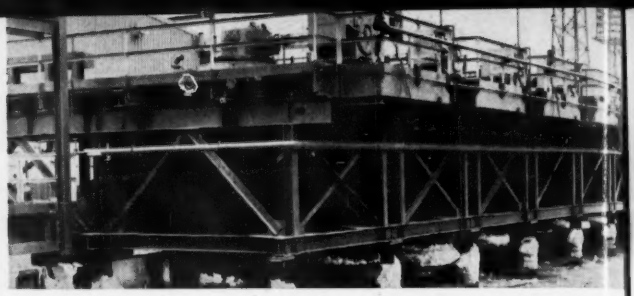
Place end of rule or scale at crest of one thread and count the spaces in 1 in. For all even threads, 2, 4, 6, 8 pitch, etc, the 1-in. mark on the rule will be directly over the crest of a thread. Number of intervening spaces or "V's" will be the pitch. Thus, if you count 8 spaces between end of rule and the 1-in. mark, you have an 8-pitch thread.

Double depth means the combined depths of two opposite thread grooves. This is important when selecting the proper size tap drill. Your screw-pitch gage probably indicates double depth on each leaf as 8-162, in which *8* indicates the pitch, while *162* is the double depth of the thread groove in 1000'ths of an in. Some tool manufacturers mark only the pitch on each leaf, stamp a tabulation of both pitch and double depth on the case where it's handy.

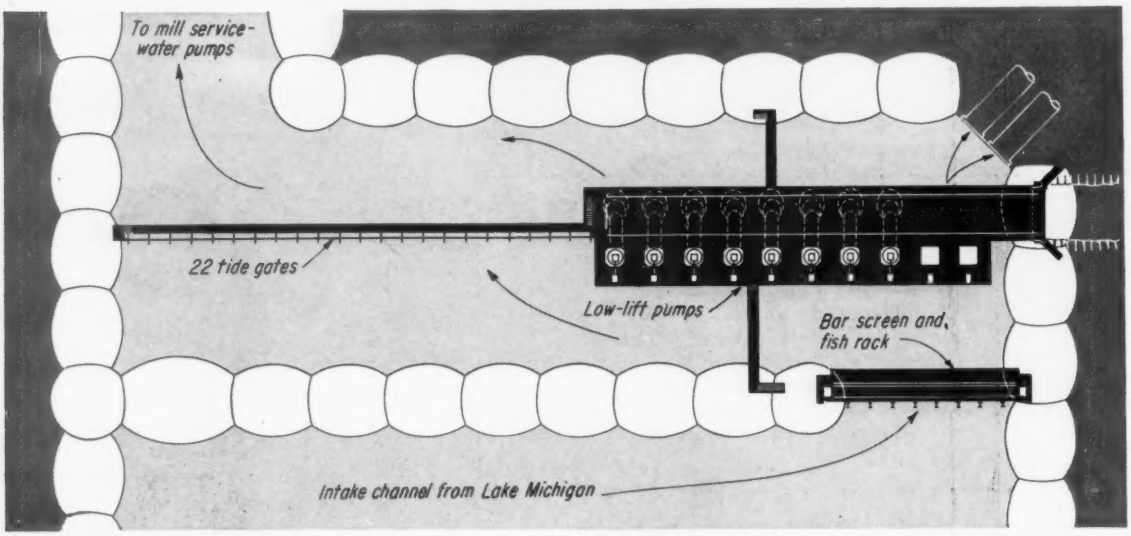
You can calculate double depth with the following simple formulas (DD = double depth, N = number of threads per in.). For sharp "V" threads: $DD = 1.733/N$ in. For American National threads the formula goes: $DD = 1.299/N$ in.

The second article in this series will deal with multiple threads.

22 TIDE GATES are capable of bypassing entire plant service-water flow of up to 1,000,000 gpm in event of low-lift-pump failure



LOW-LIFT PUMPS boost suction level for all plant service-water pumps so they can meet plant needs when lake level is low



LOW-LIFT PUMP AND TIDE-GATE STRUCTURE in forebay at Indiana Harbor Works of Inland Steel Co was completely installed without dewatering. Layer of graded dolomite laid in forebay bottom prevents scouring—velocities here can go up to five fps

Novel low-lift plant meets expanded steel-mill water needs

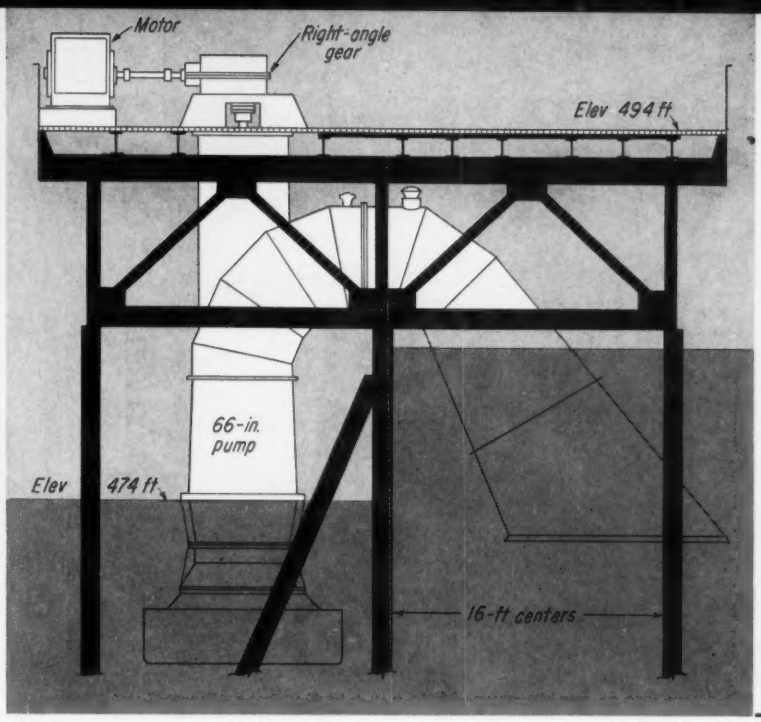
This 1½-billion-gpd pumping plant was built completely in a flowing channel without dewatering. It raises suction levels for mill-service-water pumps, lets them deliver badly needed additional capacity without strain

By ROSS NEBOLSINE
Hydrotechnic Corporation

Since 1955, the Indiana Harbor Works of Inland Steel Co has enlarged its steel-making capacity by more than 20%. To make room for this plant expansion, they filled about 500 acres of Lake Michigan and moved the shoreline out. But an existing plant-service-water intake complete with bar rack and fish screen was right in the middle of the area to be filled. So a 350-ft channel, 25-ft deep by 1000-ft long, was left open through the newly filled area.

A 90- by 340-ft forebay was installed in the channel near the old shoreline; existing bar rack and fish screen were repositioned at its entrance. From the forebay, water flows through shafts and tunnels to three plant pumping stations. (Two 96-in. lines leave the forebay directly to serve one other pumping station.)

Even before this recent plant expansion, plant operation was impaired whenever lake level went down. A study



Vertical pumps boost plant water supply

Eight 66-in. vertical pumps are each rated 100,000 gpm against a total head of 7½ ft. They're driven at 200 rpm by 300-hp electric motors through right-angle gears. Their job: raise suction level for plant-service-water pumps during periods of low lake level.

Siphon type discharge keeps total heads down, cuts hp needs. A siphon breaker prevents backflow when pumps are shut down; an automatic vent assures full discharge piping with pumps running. Airline bleeds bubbles under pump suction, prevents freezeup. Pumps and drives are heated for winter work.

clearly showed it would be impractical to revamp the already-complex service-water system throughout the plant, so a novel low-lift scheme, box, above, was evolved to artificially raise the lake water a few feet before it reached the service pumps. Improved suction permits service pumps to "run out" on their curves. They adequately meet plant needs, even when lake levels drop.

But before this low-lift pumping plant could be installed in the forebay, several design and operating problems had to be solved. First, steel-mill operation could not be interrupted during construction. So the structure itself had to be prefabricated in the largest sections compatible with easy handling to reduce underwater work.

Design problems to be overcome included: (1) Dam across entire length of forebay would have to resist a differential hydraulic head as high as 10 ft. (2) Ultimate pump capacity for 10 units would be about 1,000,000 gpm against a total head of 5 to 7 ft. (3) Platform for a heavy truck crane would be needed to service the pumps and their drives. (4) A bypass for total pump flow would have to go into the design to insure adequate flow to mill-service pumps during construction and in case of low-lift-pump failure. (5) Overflow capacity of 1,000,000 gpm back into low-level pool would be needed in case channel blocked while low-lift pumps were operating.

Design shown above, left meets each of these needs. It consists of a barrier of sheet-steel piling divided into two sections. First section, 155-ft long, is made up of ten bents. Each houses one 100,000-gpm pumping unit. Second, 185-ft long, contains 22 panels each equipped to take a 4- by 6-ft tide gate. Discharge capacity through the tide gates is 1,000,000 gpm. Sheet-piling tops of each section are cut off evenly at a fixed elevation to provide an overflow weir 340-ft long across entire width of the forebay.

Unbalanced horizontal thrust on the supporting structure can go as high as 1500 tons. 44 steel batter piles resist this thrust; each is 100-ft long to penetrate bed clay. Some of the piles had to be reinforced by cover plates to cope with eccentric-load flexure. These loads were anticipated because of the impossibility of driving piles exactly in position in a continuously flowing channel.

Since the whole structure rests on a series of open piles with no interbracing, vibration could become a problem. So each unit is fitted into and supported by a special strong-steel box truss which provides rigid support for each pump assembly. But these trusses are not rigidly joined together—reducing danger of cumulative vibration. Vibration-dampening pads are used at all important support points. Platform grating is made particularly strong to support the tire load of 40,000 lb that might be exerted by the truck crane necessarily used for all pump installation and maintenance work.

Water velocities in some sections of the forebay can get as high as five fps, so bottom erosion was a distinct possibility. The original lake-bottom sand was excavated sufficiently to backfill with graded dolomite. This 2- to 3-ft protective layer also gives lateral support to all piles without exerting any appreciable vertical load, as could be the case with tremie concrete. Lateral support is important in view of the bending moments that occur when the tops of the piles are not precisely in true position.

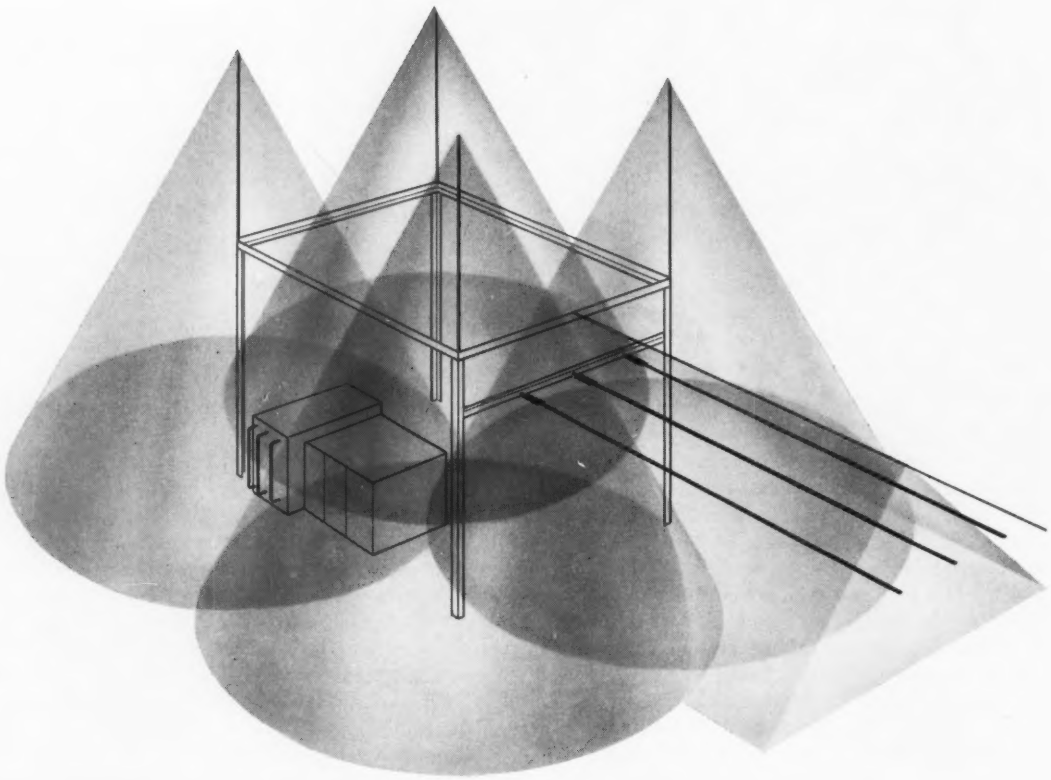
Construction of this low-lift pumping plant by the Inland Steel Co took only about six months and was completed by November 1958. Divers were needed only to check bearing-pile location and the shape of the dolomite fill in the forebay. In addition, of course, a certain amount of underwater welding had to be done to join the prefabricated sections of the structure.

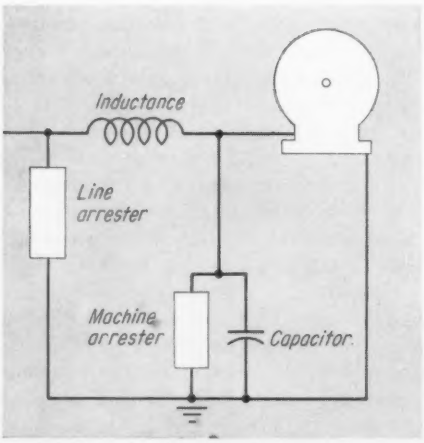
Plant Electrical Fact File

NO. 57: LIGHTNING

What about lightning?

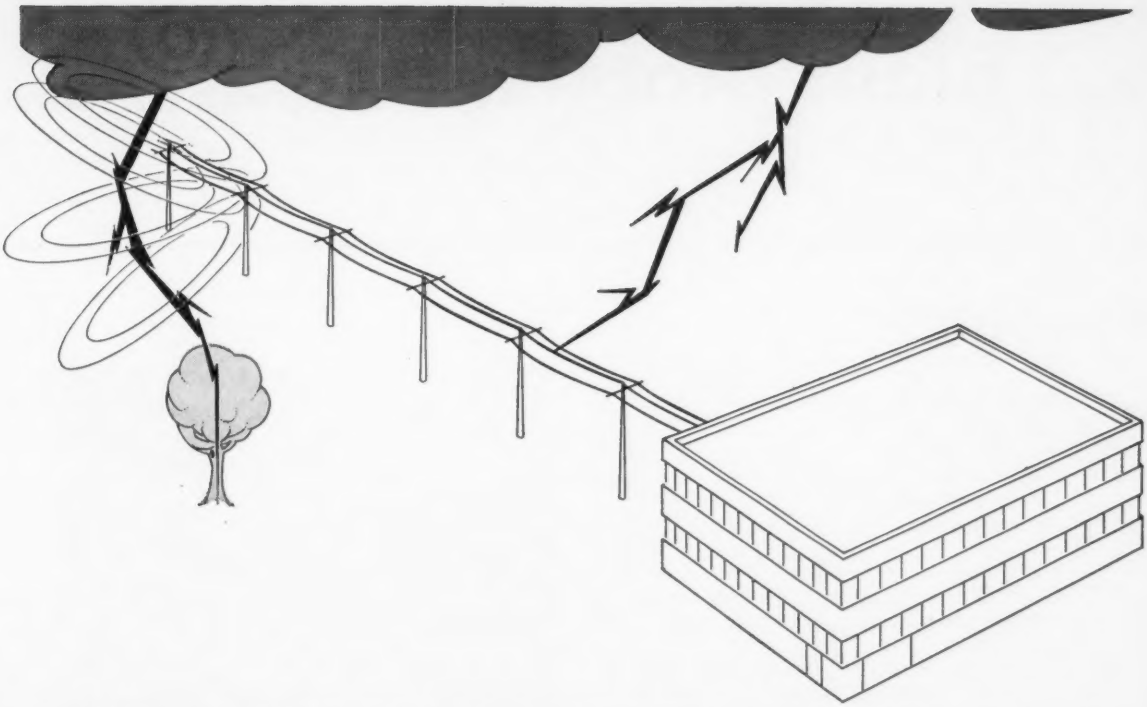
By NORMAN PEACH, Associate Editor





PROTECTION involves shielding and lightning arresters (arresters were described in *Fact File No. 45*, March 1960). Shielding is interception of lightning strokes by a good conductor well connected to earth. The conductor must be placed so it is more susceptible to lightning than equipment it protects, offering an easier path. Substation above is shielded by four masts; the incoming line is shielded by a parallel wire. Shielding angle is generally taken as about 30 deg from vertical.

Basic protective circuit for rotating machines, left, applies lightning arrester to limit voltage magnitude between machine's terminals and its frame. First arrester limits voltage of incoming line. Inductance and capacitance limit voltage rate of rise at machine terminals. Inductance may be reactor, or existing transformer or length of cable. Capacitance is usually supplied by a capacitor

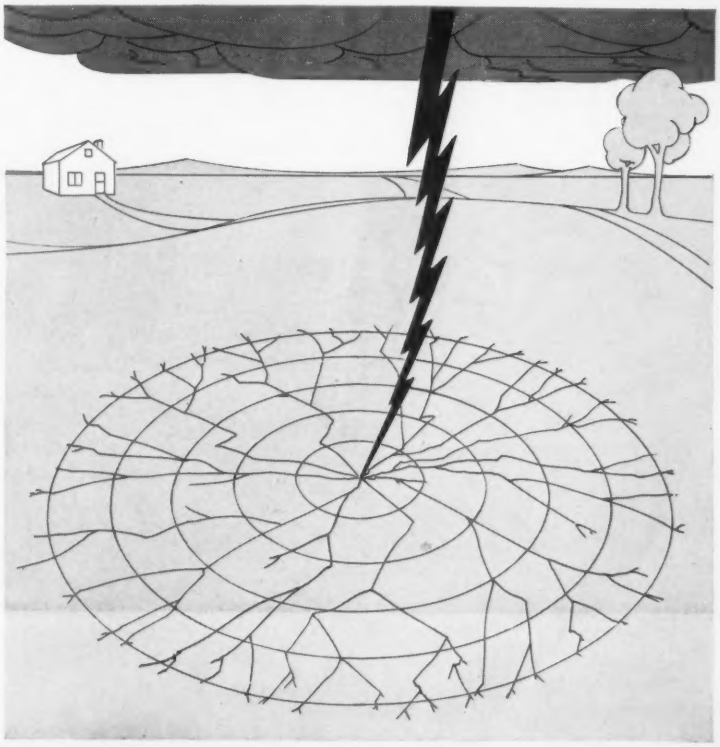


ELECTRIC SYSTEMS are affected either by direct strokes of lightning or by induction from nearby strokes. In second case high currents, 1000 to 200,000 amp, produce intense magnetic and electrostatic fields which link power lines. In either case h-v surges occur in the system—perhaps as high as 15-million volts for direct strokes and ½ million for induced surges. They may reach all the way to plant's utilization equipment. Lightning wave has a short, steep crest, longer lower-value portion.

Lightning is unpredictable—as to occurrence, magnitude and characteristics. Complete protection is never possible, but lightning arresters and shielding go a long way toward reducing hazard. Destruction of insulation by voltage surges is major form of lightning-caused damage

GROUNDING is key to lightning protection. Conductors of adequate capacity with good connections are needed to lead lightning to ground. Low-resistance paths of adequate capacity must be available in the earth to carry off the current.

Sketch shows probable effect of direct stroke to ground. As current spreads, ground impedance produces voltage drop. Voltage between locations shown by rings may be high enough to produce large currents in objects across them—lightning kills farm animals in this way. Ground gradients can also produce sparking between metallic objects close but not actually in contact. You should check ground resistance; you may have to bury a fairly extensive ground grid to get adequate grounding. Two publications will be helpful: American Institute of Electrical Engineers, No. 953 (33 W 39th St, New York 18, N.Y.); National Fire Protection Association, No. 78 (60 Batterymarch Street, Boston 10, Massachusetts)



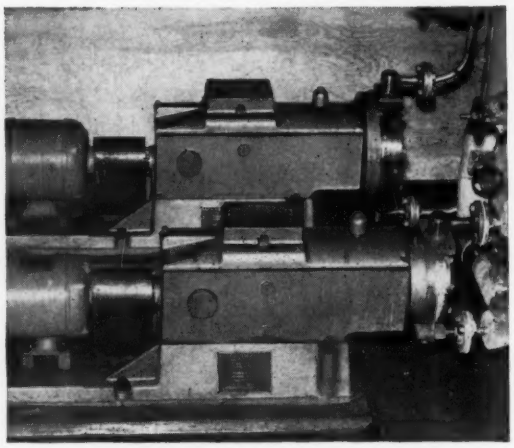
These **plant problems** could well be yours...

Problem...

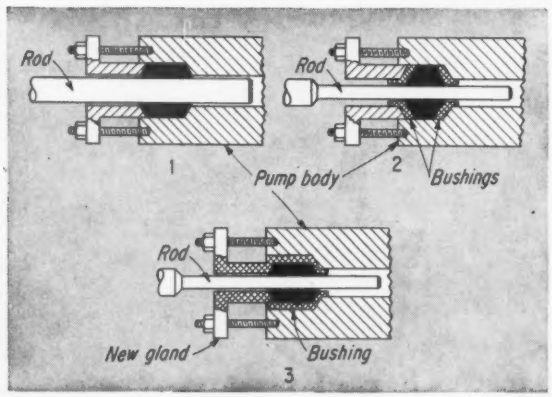
Can we cut pump capacity?

We have been using a positive-displacement (piston type) proportioning pump to inject a fuel additive into the fuel-oil service-pump discharge line. Recently we switched to another brand of additive which requires less quantity but gives better results. This brought up a problem. Our proportioning pump's volumetric capacity can be altered by changing stroke, but after adjusting to absolute minimum delivery we are still using a half gal more additive than we need per 24-hr period.

We feel that some sort of bypass back to the proportioning pump's suction is the answer, but we are not sure how to control amount of additive bypassed to guarantee desired delivery to the fuel-oil stream. Perhaps some readers have solved a similar problem. If so, we'd like to hear from them.—*RAE, January* POWER



Solutions...



Reduce pump-plunger diameter

RAE has several methods available to him to solve his additive-metering problem. The simplest way would be to find out if there is a cheap, easily available solvent for his fuel-oil additive. Mixing this half-and-half with the additive will double the volume to be handled, put it within the capacity of the pump.

The second way is the most preferable. Since the volume pumped is equal to the displacement of the piston rod, reducing the diameter of the rod will reduce the capacity of the pump below its present minimum. In my sketch at left, *1* shows the original pump. *2* shows the simplest way to reduced rod diameter. The new bushings to be made are shown, but this may result in an odd size of packing. A new gland and bushing, *2* and *3*, will keep packing size standard. However, pump as in *2* can always be quickly restored to original capacity by putting in a new rod and knocking out bushings.

The third method involves a needle-valve bypass. An air chamber should be used. The scale on gage glass could be marked in gal of fuel oil burned per 24 hr, to simplify figuring out the dose of additive. Needle valve will allow close control. A disk fitted over the valve wheel and a pointer screwed to the valve bonnet would allow for quite close control of the volume pumped.

C MILSTER, *New York, N.Y.*

...Here's how Power readers would tackle them

L E STEWART, Associate Editor

Reduce pump-motor speed

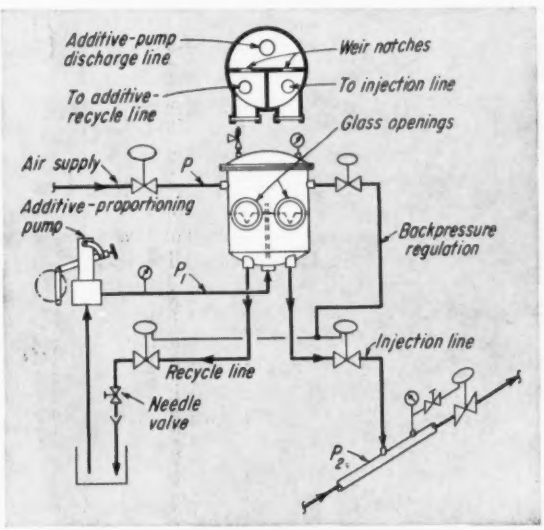
Perhaps the simpler solution would be to replace present pump motor with a lower-speed motor or have present motor rewound. This would permit *RAE* to feed at the lower rate by varying number of strokes per unit time but not the length of stroke. He would eliminate need for a bypass back to the pump's suction which, if used, would probably be inaccurate or quite expensive.

If he has compressed air available and flow rate is very low, it might be worthwhile to replace present motor with an inexpensive air motor which would let him operate the motor output speed at practically any rpm to give the required pumping rate.

Since many proportioning pumps are fitted with interchangeable cylinders and pistons for the same pump frame, it would be wise to check with the manufacturer if he hasn't already. This would allow him to change pump capacity by varying volume per stroke.

Either solution would let *RAE* operate at a lower rate without any change in accuracy. It has been our experience with several metering pumps that any unusual piping changes necessary to use a simple bypass may result in unreliable pump performance.

F STENUIS, *Leominster, Mass.*



Weir box may solve your problem

If it is impractical for *RAE* to dilute the additive with fuel oil in fixed proportion and feed the mixture to the portioning pump, here is another possibility: Use a weir box with two or more even triangular notches separately connected to injection line and to recycle line. The weir box is under constant pressure P, intermediate between pressure P_1 of additive-pump discharge line and pressure P_2 of fuel-oil-service-pump discharge line. Sketch shows one possible layout.

Air is supplied at constant pressure P to the weir box. A pilot valve, connected as shown to the regulation valves, holds backpressure of injection and recycle lines constant. A needle valve, manually operated, allows initial adjustment of the system. Glass windows help level and control the flows. J BORESTA, *West Englewood, N. J.*

Divert 1/2 gpd by bleed valve

At least four capacity adjustments are possible on a piston type pump: (1) change length of stroke (2) change speed of stroke (3) change volume of stroke—displacement (4) divert a portion of flow to the suction—recirculation. Since *RAE* is only concerned with a half gal of fluid per 24-hr period, it seems diverting this amount to a sight-collection point might satisfy his requirement. After a calibration check under operating conditions, this flow could be permitted to return to the suction-supply side of the system.

Next suggested way of cutting capacity would be to change driver speed and perhaps return stroke adjustment to some midpoint position. It is likely that changing the bore diameter would be troublesome compared with the other alternatives. M L MYERS, *Concord, Tenn.*

Timed bleed can bypass excess additive

RAE doesn't mention his pump capacity or capacity required. However, ½ gal too much in a 24-hr period is a small amount and hard to control by needle valve. I would think that, with the stroke adjustment set at the lowest point, it would be rather simple to figure how much over the required capacity is pumped per stroke.

By calculating actual displacement capacity per stroke he will find out how much too long the stroke is. If this is not more than ⅛ to ¼ in. I would think the simplest correction would be to install a microswitch tripped by a finger attached to the shaft of the plunger. With a little experimenting the microswitch can be rigged to activate a solenoid valve to bleed excess pump capacity. Similar results could be obtained by replacing the microswitch with an air pilot valve and solenoid with air-operated bleed-control valve. A C VEEN, *New York, N.Y.*

Want some help on plant problems? Send us any of your design or operating headaches for *Power* reader comment

Problem...

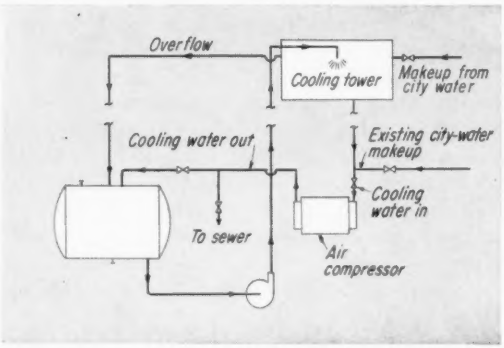
What's best cooling-water system?

We are considering installing a cooling tower and gravity system to supply cooling water to our 14x13-in. compressor. Suggested system appears at right.

Our present system uses water from city mains at 14 psi and discharges to the sewer at a rate of 600 gph. Cooling load is approximately 4800 Btu per hr.

Would a system as drawn at right be economically feasible? Can readers suggest a better means?

—*HEG, January* POWER



Solutions...

Simpler system would improve operation

The tower system as shown in *HEG*'s drawing is unfeasible both from an economy point of view and from the standpoint of good-engineering procedure.

In the first place, the tank shown in his drawing is not necessary; the tower pan acts as both a head tank and an overflow tank. Furthermore, this tank would act as a heat exchanger, picking up heat other than the heat of the compressor, thereby making it necessary to increase tower size to accommodate the extra heat-removal load.

Second, *HEG* hasn't considered the location of the makeup valve or the height of the overflow pipe in the tower pan. The cooling-tower pan is one of the most important parts of the system.

Downcomer pipe from the pan should extend into the pan to a point ¼ of the way up from the bottom. A wire-mesh screen should be fitted over the mouth of the pipe. This way any heavy sediment remains in the bottom of the pan and can be drained out from time to time, and lighter sediment cannot enter the pipe because of the strainer assembly at the top.

The makeup valve to the tower should be controlled by a ball float similar to that used in a toilet tank. It should open wide when the level of the water in the pan drops to 2/5 of the way up from the bottom, and should close tight when the height of the water in the pan reaches 3/5 of the way up from the bottom. The overflow pipe should be installed at a point 4/5 of the way up.

Since *HEG* seems to be having good results at the present 600-gph rate of flow, I suggest he continue to use this rate if a temperature close to the city-water temperature inlet can be reached. Otherwise, he will have to increase rate of flow proportional to temperature increase at compressor water inlet.

Cast-iron jackets are still used on many old compressors, and excessive pressures on these may cause porosity or cracking. Therefore, I would carefully consider where to place the tower, so that head pressure exerted on the jacket would be comparable to the existing pressure.

I would leave the city-water line and the sewer line hooked up as is, so the compressor will not have to be shut down when maintenance or repair is taking place on the tower. J L DOWNING, *Brooklyn, N. Y.*

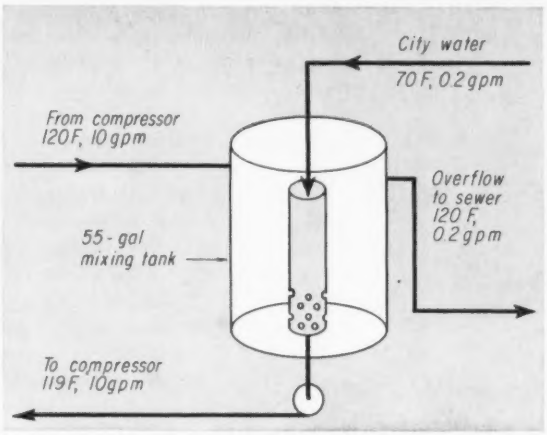
Can spent water be tapped for cooling?

Many plants are throwing away spent process water which could be used to advantage. Has *HEG* investigated all such possibilities? A cooling-tower system would seem too expensive for this small a load. Instead, a temperature-controlled regulator valve would keep water usage to a minimum and, at the same time, hold compressor temperatures within their most-efficient range.

If *HEG* must use a cooling tower, he should size it for

average or slightly above-average temperatures. Then, during short periods of high atmospheric temperatures, raw makeup water could be used for additional cooling. This will cut cooling-tower cost.

R A BROWN, *Clayton, N. J.*



Water-mixing tank could handle this load

From the data given it is not clear that a cooling tower is required. There appear to be inconsistencies in numbers such as 14x13 compressor and cooling load of only 4800 Btu per hr. Assuming the 4800-Btu-per-hr cooling load, my recommendation for a low-water-consumption economical cooling system would be—skip the cooling tower and use a water-mixing-tank arrangement as sketched. The city-water requirement would be cut from 10 to 0.2 gpm for the same 1 F differential.

If cooling load is 48,000 Btu per hr, city-water requirement would be 2 gpm. Total water consumption could be reduced by introducing a solenoid valve in the city-water line which opens when the compressor is on and closes with the compressor off. This is done by simply interlocking the solenoid valve with the compressor-motor starter.

R A EVANS, *West Hartford, Conn.*

Try auto radiator in closed system

HEG appears to have an extremely small cooling load on his air compressor to warrant installation of a cooling tower. If his total load is 4800 Btu per hr it would represent only 1 gpm of cooling water at a 10 F temperature rise. This order of magnitude can best be dissipated by purchasing an automotive radiator from a scrap yard. Radiator should be installed in *HEG*'s system with a circulating pump. With a little ductwork, natural draft alone will provide all heat dissipation required. But in extreme-ambient-temperature conditions he may need to supplement it with a small fan.

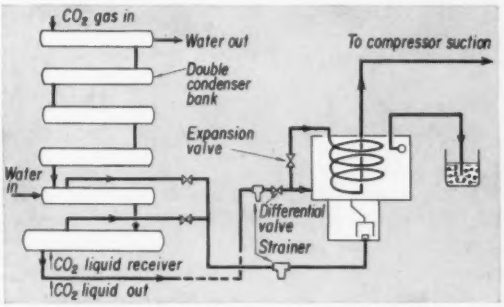
F G FEELEY JR, *Larchmont, N. Y.*

Your April problems

How can we speed snow melting?

We have a 100x100-ft blacktop parking lot adjacent to our boiler house. Our problem is snow removal during the winter—and we're situated near the Great Lakes so winter usually means lots of snow. One solution to snow removal would be to bulldoze snow into a pit approximately 4-ft wide running the entire length of the boiler-house wall. We would like to mount steam coils in the pit and melt snow as it is pushed in. Accumulated water would be handled by an existing drain in the pit.

Do any POWER readers have experience with snow-melting problems? We would like to find out whether open steam lines or closed systems are best. Also, what are heat-transfer and weight-volume characteristics of snow under various conditions?—*GAP*



What's wrong with our air purger?

We have an air purger for our 200-ton CO_2 refrigeration system, and are having trouble with purger operation.

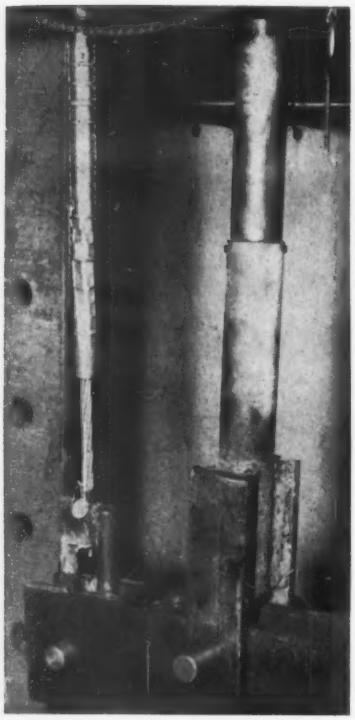
According to CO_2 liquid-receiver temperature and pressure, we have 75-psig excess pressure in the system. Compressor suction pressure is 80 psig, discharge pressure 1050 psig, condensing-water temperature 72 F. An orsat test made at the outlet of purger vent read: CO_2—95.6%, O_2—0.2%, inerts —4.2% (by difference).

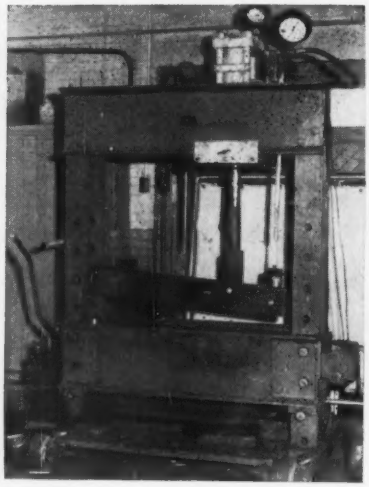
To try to find or localize our trouble, condenser tubes were thoroughly cleaned, thermometers and pressure gages checked for acuracy. All was OK.

We will welcome suggestions from any POWER reader who can help us solve this problem.—*GMD*

Sit down right now and answer one or both problems. We'll pay extra for answers with photos or sketches

Timely **practical ideas** to help solve





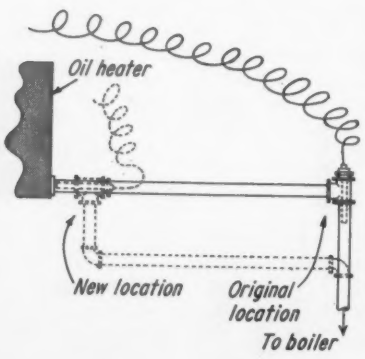
Hydraulic press: heart of makeshift tensile tester

We had no tensile testing or pulling machine. Our problem was to determine on short notice how much strain we could impose on compression joints on transmission-line aluminum conductors. Test had to be made to the "safe" calculated value for this class of joint; then we needed a destruction test.

We brought into action a 100-ton hydraulic press and rigged the test piece, photos. Knowing the beam dimensions and pressure required for a certain loading, we easily completed the job. Except for the hydraulic jack, the rig shown is entirely homemade and has a great variety of uses in our shop.

W BUCKSHEE, *Shawinigan, S, P.Q.*

Why did the temperature fluctuate?



A new plant had a 20,000-lb-per-hr packaged boiler firing low-pressure natural gas with No. 5 oil as standby. Oil-pumping and -heating set was a packaged deal also: oil pump, heater, controls and associated piping all assembled and shipped on a bedplate. When boiler was skidded in, so was the pumping and heating set. Oil suction was connected to the storage tank, the discharge to the boiler, steam to the control valve and the whole deal promptly forgotten when spring arrived and gas was available as fuel. But not for long.

Our woes started the following fall when cold weather set in and gas was again curtailed. Boiler was lit off on oil, but fire wouldn't stabilize because oil temperature was fluctuating, a severe 60 F. Set had been factory-assembled so no one gave a thought to its design. All assumed some component was faulty.

First we suspected a sticking control valve. The valve was disassembled, inspected and found clear of trash. Valve stem was polished and trued up but after reassembly the rhythmic 60-F fluctuation continued. Then we suspected the steam trap but found it to be OK. Someone even suggested a faulty thermometer. Even though the radical fire vetoed that we swapped out the thermometer. Still no change.

The controller was a nitrogen-filled bulb, inserted in heater discharge line through a tee with a hollow flexible piece of tubing running back to a direct-acting diaphragm valve, sketch. Someone decided that either the gas-filled bulb or the flexible line was leaking nitrogen and causing the trouble. Hence a new controller was installed exactly as the factory original. But the doggone thing still fluctuated the same 60 F.

About this time I arrived on the scene. But I must confess it took 24 hr before the light finally dawned. In that time these facts emerged: (1) The heater was oversized. Seems manufacturer built a standard set for any size of packaged boiler. Heater was sized for his largest unit—40,000 lb per hr. (2) Discharge piping from the heater was oversized to accommodate the temperature-sensing bulb since baffling in the heater prevented direct insertion of bulb. As a result, oil velocity through the discharge line was very slow and the oversized heater acted as a reservoir. (3) Temperature-sensing bulb was removed 10 ft from the heater itself.

When pump started, oil passing the bulb was cold. This threw the control valve wide open. Thus it re-

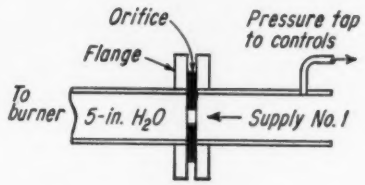
your tricky design and maintenance problems

STEVE ELONKA, Associate Editor

mained until all cold oil passed the bulb. By this time the reservoir of oil in the heater was well above the desired temperature. When this hot oil started passing the bulb, the control valve shut off until all oil had passed. Then the reservoir was full of cold oil and the cycle restarted.

Solution: simply move temperature-sensing bulb as close to heater as possible, sketch. This reduced fluctuation to an acceptable 8 F.

L A WATSON, *Atlanta, Ga.*



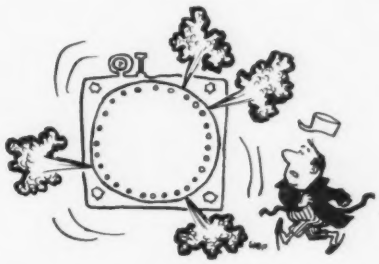
Orifice solves problem

Our boiler and combustion controls were purchased on separate contracts and with very little coordination. The boiler was equipped with low-pressure gas burners that reached full load at 5 in. of water pressure.

Gas flow for control purposes was measured as a function of burner pressure. But the gas-pressure sensing device had a range of 3 oz to 1 lb. That meant we reached overload at minimum stop. And we could not order a new bellows as the control manufacturer didn't make one with any lower pressure range. Plugging nozzles in the burners to raise their operating pressure was suggested. But when we tried this it only made the burners unstable.

Solution was simple and quickly done. Gas was supplied to the burner through a 5-in. pipe attached to the burner with a standard ASA 125-psi bolted flange. We simply put a 14-ga orifice in the flange, sketch. It was sized so when the burner pressure reached 5 in. of water the upstream pressure was 1 psi. This hookup worked fine, is probably still operating exactly as we installed it.

L A WATSON, *Atlanta, Ga.*



What would you have done?

Years ago, my first job was in a power plant equipped with three engines and four box-header boilers. After working in both engine and boiler room I became the boiler-room foreman.

One morning about two am my telephone rang. Watch engineer excitedly yelled that both feed pumps had stopped, the injector refused to catch, water was down to one in. in No. 3 and completely out of sight in No. 1. I told him to close certain steam valves on the boilers to conserve what water was left; then I took off at a dead run, racking my brain for a solution as I charged along.

Arriving, I found he hadn't understated the situation. There was no sign of water in No. 1 glass. In No. 3 the water was at the bottom nut. Fireman and engineer were panicky and ready to take off at the first hiss of steam. Neither pump would run. But I had other things on my mind. Our injector when handled right performed nobly, went to work keeping No. 3 boiler's water in sight.

I opened the front of No. 1 boiler. Then I rubbed a piece of oil- and water-soaked waste over the hot drum end. By watching this oil-water mixture bubble, I could roughly tell that the water level was high enough to keep the tubes from burning. I brought the level higher, then turned to the feed pump.

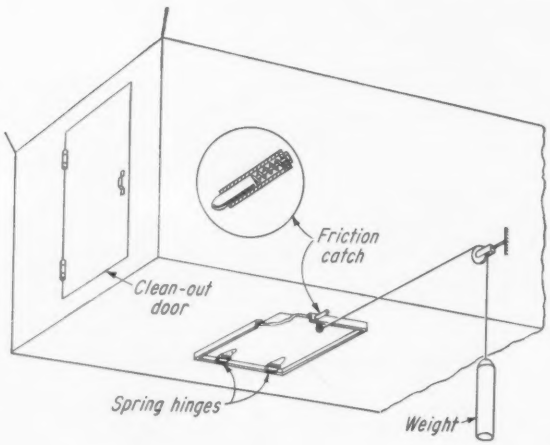
I reasoned that odds were against two well-maintained pumps conking out at same time. Both pumps were regulated by a single constant overpressure regulator. Playing a hunch, I cracked the union in the small line leading from the diaphragm to a point downstream in the water line. There was a spurt of rusty water, then pumps started simultaneously. The small line had gradually filled with rust and gunk, which had trapped pressure on the diaphragm, keeping the steam valve closed.

It was sunup by time I replaced this pilot line. After talking with the boys about their close brush with death and disaster, I went on my way. Guess I was feeling smug and self-satisfied, something akin to Marmaduke after he engineers a famous coup. But no employer met me at the door with gargle juice or a fist-full of $100 bills. No pretty señoritas smothered me with gardenias or kisses. My only reward was the satisfaction of meeting my first emergency head-on and mastering it. What would *you* have done?

A B HARPER, *Rochester, N. Y.*

Do you know...

the effect of closing the intake of a large forced-draft blower—especially a centrifugal type? You'll find answer to this and hundreds of everyday operating problems in *Standard Plant Operator's Q & A*, McGraw-Hill Book Co.



Now, automatic fines dumper gives us warning

Air ducts for our underfeed stokers extend along the basement ceiling directly under the stokers. They measure 60x60 in. x 45 ft. Siftings and fines fall through the grates and must be cleared from the ducts at intervals. Only access for inspection or cleaning is through two 24x40-in. doors located in either end of the duct—a tight squeeze at best.

For the past year, during plant rehabilitation, contractor's equipment has jammed up the basement space. As a result regular duct inspections and cleanings have gone by the board. We were reminded of this a few weeks ago—we heard a sudden crash, found part of the air duct smashed down on the basement floor under an internal load of fines. The stoker's whole underside was left exposed.

We made an emergency repair by rebuilding the duct with welded sheets of iron and angle steel. To guard against a future snafu we developed idea shown in sketch.

In the duct bottom directly under each stoker we cut a 24-in.-sq hole and covered it with a piece of ⅛-in. steel plate. Plate fits into a 1-in. angle framework which keeps the door in line, prevents ductwork from buckling. The door is fastened with heavy spring hinges, counterbalanced by hanging weights on cables running over pulleys attached to the edge of the door. Weights are calibrated to support the weight of the door plus about 40 lb. This is equal to a 2-in. layer of fines over the door. A friction catch prevents premature opening.

Siftings and fines still fall as before. But when more than 2 in. accumulate on the door, the weight offsets the balances and the catch swings open, dumping its load. The balances reclose it. So one or more of three things happen to quickly warn the operator that his duct needs cleaning: (1) a load of fines appears on the basement floor (2) a high-velocity-air whistling noise is heard as the door begins to open (3) a sudden drop in wind-box pressure shows up on the gages.

C VAN HUBEN, *Orangeburg, N. Y.*

My biggest boner

We had to boil out a 30,000-lb-per-hr boiler. We used a normal boilout concentration of 3000-ppm caustic soda and 3000-ppm trisodium phosphate. Boilout was started Friday am. It was to last through Sunday pm with the pressure being off and the unit cool enough to drain by Monday am. All that had to be done over the weekend: intermittently fire the unit to maintain boilout pressure and occasionally blow down the mud drum and the water column to keep chemicals from plugging the valves.

With so little to do over Saturday and Sunday I decided to leave the job Friday night and go home for the weekend. First I left explicit instructions for handling the boiler.

When I returned Monday am the pressure was off and the unit cool enough to drain. Apparently instructions had been followed well. But—wait a second. When the mud-drum blowdown valve was opened to drain the unit, nothing came out. It seems the operators had neglected one little item—blowing down the unit once a shift to keep the valves clear.

No amount of backflushing would unplug the valve. And this was the only drain valve on the unit. Finally, a pipefitter dressed in rubber boots, gloves and raincoat had to remove the valve completely. Then the highly caustic boilout solution was drained onto the boiler-room floor. What a mess!—L A WATSON, *Atlanta, Ga.*

Try using solder on those loose bolts

At times frequent removal loosens a bolt or stud in its socket. It may not be practical to redrill and retap the hole to a larger size. I've solved these problems by building up the bolt or the well-cleaned threaded end of the stud with a thick coating of solder. This method will often do the trick if high temperatures aren't involved.—H STEIN, *Branson, Manitoba*

How about that boner?

It takes a modest man to tell his boners. But we all pull them. What was *your* biggest boner? It's worth $15 and may save someone else from making the same mistake.

Switching to nickel-iron-chromium drip lips pays off in . . .

Lower ash-hopper maintenance

Burning some 1000 tons of pulverized coal per 24 hr, the 185-mw steam generator at Long Island Lighting Co's Barrett Station drops a ton of bottom ash each hr into a hopper beneath the boiler. The hopper, about 40-ft long and 20-ft wide, is partially filled with water drawn from the nearby Atlantic Ocean to quench hot slag and ash before it sluices to the disposal area.

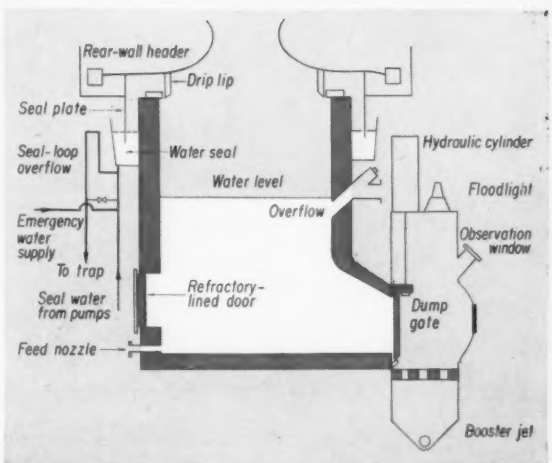
Because the boiler furnace and ash hopper are under negative pressure, a water seal surrounds the hopper. To protect the seal from fouling with ash and becoming ineffective, a vertical baffle called a drip lip is hung from brackets welded to the waterwall tubes. It extends around the ash-hopper perimeter, right.

When originally installed as part of the boiler erection the drip lip consisted of ¼-in.-thick cast-iron plates coated with 1-in. refractory over wire lath. As time went by these began to present problems.

Thermal shock played its part: thermocouples showed that drip-lip surface temperatures ranged from 500 to 700 F. As slag and ash plunked into the hopper, cold sea water splashing against the hot refractory caused severe spalling. Cast-iron backing plates, unprotected after the refractory had fallen away, would crack under the repeated heating and quenching cycle. Hot salt water and vapor took their constant toll of corrosion.

Service life of the combination proved to be about six months. Repair and replacement became expensive in terms of outage time and man-hours—about 400 for complete replacement. This was added to materials cost.

Investigation to find relief from this headache resulted in choice of nickel-iron-chromium plate as a substitute. A few sections installed experimentally quickly proved themselves so the material was used to complete the drip lip. Costing less to install, from both labor and material standpoints, the baffle has been in place for the past two years and, to date, has resisted oxidation, hot clinker impact and, of course, repeated thermal shock.



NEGATIVE PRESSURE in furnace and ash hopper requires a water seal. Drip lip must protect seal from being clogged by slag and ash

IT CAN HAPPEN HERE

"My dear son

I am so sorry you are going to have to live under Communism.

It seemed to come so quickly.

I didn't think their lies could win.

I guess we were so busy with other things.

Not enough of us spoke up for freedom when we had the chance."

You can speak up for freedom right now

Your dollars are needed to help build the American Freedom Center at Valley Forge. You can speak up for freedom by contributing Freedom Bricks.

The Freedom Center will provide research and library facilities for all individuals, groups and organizations seeking to defend and interpret the free American system. It will house the award-winning materials of over one million entries in Freedoms Foundation's eleven annual National Awards Programs.

Freedoms Foundation was founded in 1949 to help maintain the American Way and pass it on intact to each generation. You can strike an effective blow *against communism* by joining Freedoms Foundation's FOR AMERICANISM program. The Foundation is nonprofit, nonpartisan, nonsectarian. Membership is open to all patriots. Dwight D. Eisenhower is Honorary Chairman.

FREEDOMS FOUNDATION
VALLEY FORGE, PA.

Yes, I want to help build The American Freedom Center. Here is $_____ for _____ Freedom Bricks at $1 per brick.

I am enclosing $_____ as an additional contribution to make me a member of Freedoms Foundation.

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*City*_____ *Zone*____ *State*_____

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So why not save time by calling in a specialist who knows the ground you are exploring?

POWER, meeting place of power men in all parts of the country, points the way to the solution of many power problems through its Professional Service Section.

CHAS. T. MAIN, INC.
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WATER SERVICE LABORATORIES INC.
Specialists in Water Treatment for Corrosion Prevention
Main Office
615 West 131 Street · New York 27, New York
Offices also in Phila., Wash., & Richmond, Va.

SEARCHLIGHT Equipment Locating Service

No Cost or Obligation

This service is aimed at helping you, the reader of "SEARCHLIGHT", to locate Surplus new and used power equipment not currently advertised. (This service is for USER-BUYERS only. How to use: Check the dealer ads on pages 196-201 to see if what you want is currently advertised. If not, send us the specifications of the equipment and/or components wanted on the coupon below, or on your own company letterhead to:

SEARCHLIGHT EQUIPMENT LOCATING SERVICE
c/o POWER—Classified Advertising P.O. Box 12, New York 36, N. Y.

Your requirements will be brought promptly to the attention of the equipment dealers advertising in this section. You will receive replies directly from them.

SEARCHLIGHT EQUIPMENT LOCATING SERVICE, c/o Power, P. O. Box 12, New York 36, N. Y.
Please help us to locate the following used equipment:

.....

.....

NAME..... TITLE..... COMPANY.....

STREET..... CITY..... ZONE..... STATE..... 4/61

CONSTRUCTION

PROJECT SUPERINTENDENTS

Project Superintendent to take complete charge of construction of 300 MW Thermal Power Plant including coal handling & circulating water systems and all Field Personnel facilities. Location Far East. Assignment 3 years duration.

Project Superintendent to take complete charge of construction of 15 MW Thermal Power Station, including 2 Turbine-Generators each 7.5 MW with coal handling & circulating water systems. Location Far East. Assignment 2 years duration.

ASSISTANT PROJECT SUPERINTENDENTS

Assistant Project Superintendent, Civil, for construction of 300 MW Thermal Power Plant including coal handling & circulating water systems; and all Field Personnel Facilities. Location Far East. Assignment 2 years duration.

Assistant Project Superintendent, Civil, for construction of 130 MW Power Station including 2 Turbine-Generators, each 65 MW and complete circulating water system. Assignment 2 years. Location Far East.

Assistant Project Superintendent, Civil, for construction of 300 MW Thermal Power Station consisting of 4 Turbine-Generators, each with 75 MW with coal handling & circulating water systems. Location Far East. Assignment 20 months.

Men must be thoroughly exp. by having previously performed function for which application is made. Salary commensurate with experience. Liberal company benefits. Write giving detailed work resume; essential personal data & minimum salary required. All applications acknowledged. All replies confidential. Send complete resume to the

KULJIAN CORP.

Personnel Employment

Construction Division

1200 N. Broad St., Phila. 21, Pa.

MECHANICAL ENGINEERS

Immediate opening for Project Manager and Project Engineer experienced in design of power plants; piping; and heating, ventilating, and air conditioning. Extremely wide variety of work with established Midwest consulting firm. Permanent. Good starting salary, advancement, and vacation program. Moving expenses paid. Send complete resume to

P6349, POWER
520 N. Michigan Ave., Chicago 11, Ill.

INSTRUMENT ENGINEERS

Major west coast engineering and construction firm has openings for senior engineers experienced and qualified in instrumentation and/or systems engineering. To assume full job responsibility on a project level for the instrumentation and control of processing, industrial and power plants. Would prefer experience in electronic control and digital information systems.

Relocation allowances cover moving costs plus transportation reimbursement for you and members of your family. If you have an interest in a San Francisco assignment, please send a resume of experience, including your present and required salary, to George I. Copeland, Manager of Personnel. A personal interview will be arranged for qualified applicants.

Bechtel
Corporation

220 Montgomery Street
San Francisco, California

SEARCHLIGHT SECTION

Classified Advertising

EMPLOYMENT: BUSINESS: **"OPPORTUNITIES"** EQUIPMENT USED OR RESALE

ADDRESS BOX NO. REPLIES TO
Box No. Classified Adv. Div. of this publication.
Send to office nearest you.
NEW YORK 36: P. O. Box 12
CHICAGO 11: 520 N. Michigan Ave.
SAN FRANCISCO 11: 255 California St.

POSITION WANTED

Chief Engineer, age 39, technical education, 15 years experience in the operation, maintenance, construction, and betterment of turbo-electric power plants. PW-6183, Power.

SELLING OPPORTUNITY WANTED

Manufacturers Representative desires additional industrial equipment account for exclusive sales coverage. Engineering sales office located Philadelphia area covering Pennsylvania, New Jersey, Maryland and Delaware. RA-6306, Power.

WANT MORE MONEY WANT BETTER JOB

GET 2nd CLASS ENGINEER Lic. IN 1 YR.

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Apply for monthly Boiler Room 100 Question & Answer Bulletins. After 15 months, take Custodian or Supt. of Bldgs Civil Service Examination.

For information write:

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88 Ashwood Dr. Rochester 9, N. Y.

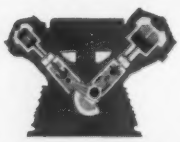
Circle 500 on Reader Service Card

WE PAY
$ CASH $
FOR
Electric Motors • Starters • Transformers
Circuit Breakers — Electric Supplies
ALLIED ELECTRIC CO.
710 N. MAIN ST., MEMPHIS, TENN.
BOX 1688 — PHONE JA 7-1681

Circle 501 on Reader Service Card

BOILERS, TURBO GENERATORS PUMPS, FANS and STEAM SPECIALTIES
One of Nations Largest Inventory
New and Used
WABASH POWER EQUIPMENT CO.
Staff of Professional Engineers
3300 West Peterson, Chicago 45, Ill. IN 8-0303-04

Circle 502 on Reader Service Card



ANSWER

to Worthington Hidden Value Puzzle

The fictitious "hidden value" on the back cover is, of course, the "Articulated Connecting Rod." This design is found only on light duty compressors with single acting cylinders.

The true Worthington connecting rod construction is shown above. Each rod is directly mounted on the main crankshaft, giving greatest bearing area and stronger linkage. There are fewer parts in all, maintenance is simpler and lubrication is less complex. Worthington Corporation.

75 TON BRIDGE CRANE

1—75 Ton capacity Whiting Mfg. Co. bridge crane with auxiliary hoist, 51 ft. span, complete with operating motors, control and rail.

Excellent condition.

Can be inspected in operation.

UTILITIES MACHINERY CORP.
1965 EAST SIXTH STREET
CLEVELAND 14, OHIO

Circle 503 on Reader Service Card

MODERN POWER BOILERS

1—Babcock & Wilcox	—122,000#s/hr—	—250 psi
3—Combustion-Engineering	—110,000	—200 psi
1—Riley	—100,000	—435 psi
1—Babcock & Wilcox	—100,000	—450 psi
1—Babcock & Wilcox	— 90,000	—265 psi
1—Combustion-Engineering	— 75,000	—250 psi
1—Riley	— 70,000	—250 psi
2—Babcock & Wilcox	— 70,000	—450 psi
1—Riley	— 60,000	—290 psi
2—Combustion-Engineering	— 50,000	—250 psi
1—Babcock & Wilcox	— 45,000	—450 psi
1—Combustion-Engineering	— 40,000	—220 psi
1—Foster-Wheeler	— 40,000	—200 psi
1—Babcock & Wilcox	— 35,000	—800 psi
2—Riley	— 35,000	—250 psi
1—Babcock & Wilcox	— 27,500	—450 psi
2—Riley	— 19,000	—200 psi

MIDWEST BOILER & TURBINE CO.
WARNER NEW HAMPSHIRE PHONE 244

Circle 504 on Reader Service Card

TRANSFORMERS

For Sale

3—2500 KVA G-E 69000—2400/4160Y
3—2500 KVA G-E 69000—7200/12470Y

THE ELECTRIC SERVICE CO.
5322 Hetzel St., Cincinnati 27, Ohio

Circle 505 on Reader Service Card

DUAL-FUEL POWER PLANTS

2360 KW Nordberg, 21½" x 31"; 225 RPM; New '52; 36,000 Total Hours; 3/60/4160V, Full Load Test BTU Per KWH, 9316 as of 12-60. Priced F.O.B. Midwest at $257,000.00.

2—1000 KW, New; Electro-Motive Division, G.M.C.; Skid Mounted 16-567-C Engines, @ 720 RPM, complete with all accessories; 3/60/2300/4160V Heat Exchanger Cooled, Less Switchgear; $87,700. each, F.O.B. Cars, Midwest; 12 Months Warranty.

Preston W. Duffy & Son
193 E. Beck St., Columbus 6, Ohio

Circle 506 on Reader Service Card

BOILERS

2 drums each; 14 sections each; 196—4" tubes each; 14 case steel headers each; hand holes are oval inside gaskets; 200# gage although we were operating at 125# gag; steel supports and hangers; 2 pressure gages; 2—6" stop valves; 2—6" non-return valves; 2 dampers; 4 header doors; 4 fire doors; 4 ash pit doors; 8 diamond soot blowers less elements; 2 water columns; 4 blow-off valves; 2 Copes feed water elements; 2 boiler fronts.

These boilers were inspected March 9, 1961 by our Insurance Company and we have operating certificates.

Bids to be—R. R. siding Power Plant.

UNIVERSITY OF ROCHESTER
River Campus Station, Rochester 20, N. Y.

Circle 507 on Reader Service Card

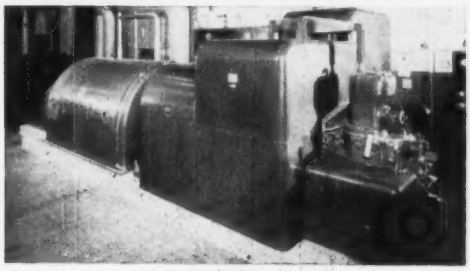
Modern 850lb. 850°—6250 K.V.A. Turbine Generator

80 to 160 lb. Back Pressure

Immediately

Available

Excellent Condition



Actual Photograph

Generator

3/60/2400, 80% P.F.

Built by Westinghouse

Other turbine Generators

1-2000 KW GE	600#750° Non-Cond. 150# BP 4160V/6600V
2-3000 KW Westinghouse	600# 750° Non-Cond. 125/150# BP 2400V
1-3000 KW Westinghouse	400# 750° Cond. 6600/4160V
1-2500 KW Westinghouse	125# Non-Cond. 10# BP 2300V
1-6000 KW GE	200# Condensing 2300V
1-7500 KW Allis-Chalmers	850# 850° Non-Cond. 110# BP.

1—33,000 KW General Electric 950 lbs. 950°, 3/60/13,800 Volts

Cable Address: CHASWEAVER

CHARLES WEAVER, INC.

19701 JAMES COUZENS HIGHWAY

DETROIT 35, MICHIGAN

Telephone: BRoadway 3-1900

Circle 508 on Reader Service Card

DIESEL GENERATOR SETS

(4) NEW 500 KW GM 8-278

Engines — 715 HP — Vee type — 8 cylinder — 8½ x 10½ — air starting — 720 RPM — 2 cycle — heat exchanger cooled. Engines drive 500 KW Allis-Chalmers D.C. generators—120/240 — 2080 amps — 720 RPM — compound wound. Complete with a very generous supply of spare parts. IF YOU NEED D.C. POWER, NOTHING CAN BEAT THIS VALUE. FULLY GUARANTEED.

NOTE:

We can also quote you using the above engine — radiator cooled and with an A.C. generator — either 440/2300 or 4100 — and offer a completely portable unit.

EXCELLENT GENERATORS FOR STANDBY POWER

(1) UNUSED 250 KW UNIT

440/3/60 — 900 RPM Westinghouse generator — driven by a Cooper-Bessemer 8¾ x 11 engine model F.S.6 — Heat exchanger cooled. This is an unused set in prime condition. Will demonstrate. Unit is a slow-speed heavy duty diesel generator.

(4) AS ABOVE, RECONDITIONED

With Switchgear

Send us your inquiries

THE BOSTON METALS CO.

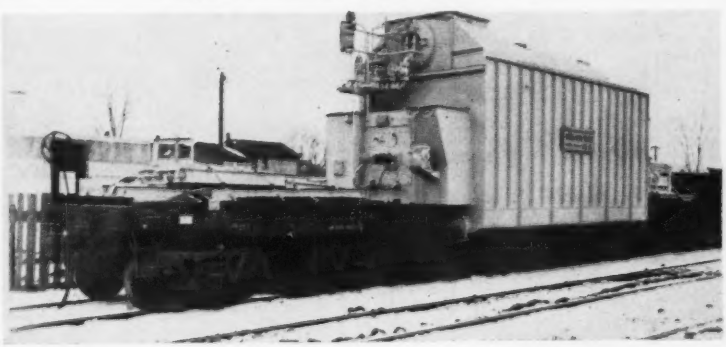
313 E. Baltimore St., Baltimore 2, Md.

ELGIN 5-5050 LEXINGTON 9-1900

Circle 509 on Reader Service Card

NEW—UNUSED—ASSEMBLED

88,000 LBS/HR -- 235 PSI.



Union Iron Works package type water tube boiler, model MH-T, rated at 88,000 lbs/hr.—235 psig assembled, and delivered new in 1960—never placed in operation—steel encased and capable of being shipped intact aboard RR car without dismantling. IMMEDIATE DELIVERY. Fully equipped.

INDECK POWER EQUIPMENT CO.

9750 N. Skokie Blvd. Chicago (Skokie), Illinois

ORCHARD 3-7666

Circle 510 on Reader Service Card

MOTOR GENERATOR SETS

Q	KW	MAKE	D.C.	A.C.	RPM
5	750	G.E.	250	3/60	720
1	500	Elliott	125	3/60	720
2	300	G.E.	250	3/60	1200
1	150	West.	250	3/60	1200
1	100	Star	250	3/60	1200

STEAM- TURBO- GENERATORS 3/60

Q	KW	MAKE	TYPE	I.S.P.	YEAR
1	10000	West.	Cond.	275	1952
1	7500	G.E.	Cond.	273	1946
2	7500	West.	Cond.	400	1945
1	5000	West.	Cond.	400	1936
1	5000	West.	N. Cond.	850	1941
1	3000	G.E.	Cond.	400	1940
1	2500	G.E.	N. Cond.	180	—
1	2000	G.E.	N. Cond.	180	—
1	1000	Elliott	N. Cond.	325	1930
2	1000	Elliott	Cond.	150	1949
2	300	G.E.	Cond.	400	1945

PACKAGE BOILERS

Q	HP	MAKE	W.P.	FIRING	YEAR
1	600	T'ville	150	#6	1950
1	400	Cl. Bk	150	#6	1948
1	200	Superior	125	#6	1957
1	200	Erie	160	#6	1951
1	150	Cyclotherm	150	#6	1947
1	150	Cl. Bk	15	#6	1954
1	80	Cl. Bk	125	#6	1948
1	70	Ames	15	#2	1951

DIESEL GENERATOR SETS

Q	KW	MAKE	VOLTS	RPM
2	2000	Baldwin	230V.D.C.	257
2	1000	G.M.	3/60/2400	720
1	626	Alco	240V.D.C.	700
1	330	Worth.	3/60/480	600
1	300	G.M.	3/60/230-440	1200
2	200	G.M.	3/60/220-440	1200
2	125	Worth.	3/60/480	600

AIR COMPRESSORS

CFM	PSI	MAKE	TYPE	H.P.	VOLTAGE	RPM	YEAR
7550 (2)	34/30	I.R.	XHB	600	3/60/4160	300	1945
6000	125	Sullivan	H	1250	3/60/2300	300	1943
1853	125	Worth.	DC-2	300	3/60/2300	277	1946
1530	125	Worth.	OXP	250	Steam	300	1943
1308	125	C.P.	OCB	225	3/60/440	257	1937
1300	125	I.R.	XRB	225	3/60/440	257	1940
570	125	Gardner	WBK	150	3/60/440	870	1951
515 (4)	125	I.R.	40	100	3/60/440	870	1940/50
500	125	I.R.	K500	Diesel Portable			1948
494	125	I.R.	XRB	75	3/60	277	—
464	100	I.R.	ES-1	75	3/60	300	1950
363	100	I.R.	ER-1	60	3/60	277	Late
250	2500	Worth.	3 stg.	175	3/440	257	Late
218	200	I.R.	40	50	3/60	870	Late
211	100	I.R.	R.S.	40	3/60	325	1946
174	125	Worth.	H	30	3/60	300	1940
173	100	I.R.	E.R.	30	3/60	300	1945
78	350	I.R.	ES-2	30	3/60	300	1954
8.8	2500	I.R.	ES-2	20	3/60	350	1945

"Everything from a Pulley to a Powerhouse"

THE O'BRIEN MACHINERY CO.

R. M. REG. INTERLD. U. S. PATENT OFFICE

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BAldwin 8-1480
• Cable Address
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1937 W. CLEARFIELD ST., PHILADELPHIA 32, PA.

Circle 511 on Reader Service Card

NEW EQUIPMENT FROM THE UNCOMPLETED

BATTLESHIP U.S.S. KENTUCKY

Installed but never used
Built of finest materials

WESTINGHOUSE 1250 K.W. TURBO-GENERATORS

(4)—Westinghouse—440/3/60—850°—540 lbs. working pressure. Complete with condensers, circulating pumps, etc.

BOILERS

7 B&W EXPRESS TYPE

Design pressure 634# — operating pressure 565# — temp. 850°F. Oil fired — separately fired superheaters. *Capacity: 210,000 lb.* steam/hr. ideal for testing where large quantities of steam are required, giving excellent control from separately fired superheaters. Can be converted for #2 oil and natural gas. Fully automatic.

LARGE DEAERATING FEED HEATERS

Monel construction — spray type — capacity 480,000 lbs./hr.—vent condenser—single pass —heating surface 174 sq. ft.—all Monel construction.

GE HIGH AND LOW PRESSURE MAIN PROPELLING TURBINES

Will sell separately for testing, wind tunnel or similar work. (2) high pressure—24,400 HP—12 impuse stages—4909 RPM—working pressure 540 lbs.—825°F. (2) low pressure—28,600 HP — 3913 RPM — working pressure 49 lbs. steam—424°F—2-6 stages of impulse.

FEED PUMPS

Ingersoll-Rand—5"—three stage—500 GPM at 750 lb. discharge. BHP 330—5000 RPM—Worthington turbine—573 lbs.—non-condensing—back pressure 20 lbs.

FORCED DRAFT BLOWERS

29,000 CFM—max. static 35"—normal 21".

LUBE OIL COOLERS

MANY OTHER ITEMS FOR SALE.
SEND US A LIST OF YOUR REQUIREMENTS

THE BOSTON METALS CO.

313 E. Baltimore St., Baltimore 2, Md.
ELGIN 5-5050 — LEXINGTON 9-1900

Circle 512 on Reader Service Card

TRANSFORMERS—60 CYCLE

QU.	KVA	MAKE	TYPE	PHASE	VOLTAGE
3	3000	Moloney	TCR	3	7200-4160/2400
2	3000	G.E.	OA-T	3	26,400-4160/2400
1	1500	West.	O.I.S.C.	3	26,400-480 taps-hi
3	500	G.E.	K.S.T.G.	1	4150-2400
1	300	Pacna.	OA Askarel	3	12,470Y/7200-240
3	200	Amer.	C.C.	1	4160/7200-240/480
3	200	G.E.	HS-W28	1	2400/4160-240/480
3	100	Wagner	HS	1	2300/4160-220/440
3	75	G.E.	H-form K	1	2400/4160Y-120/240
3	50	G.E.	H-form K	1	2400/4160Y-220/440
3	50	Niagara	Dry-air	1	2400/4160Y-120/240
3	50	Harrison	Dry-air	1	2400/4160Y-220/440

MOTOR GEN. SETS

QU.	KW	MAKE	SPEED	D.C.	A.C.
1	1000	West.	720	600	2300/4160 S.R.
1	400	West.	1200	250	3 units 4160 V. syn.
1	300	G.E.	1200	250	2300/4160 syn.
1	300	Al. Ch.	1200	125/250	3 units 440 syn.
1	175	West.	1200	125	4160 syn.
1	100	West.	900	250	4160 syn.
1	45	G.E.	1170	30	440V Sq. Cage
2	30	G.E.	1760	230	440V Sq. Cage

D.C. MOTORS — 230 VOLT

QU.	HP	MAKE	SPEED	TYPE
1	350	G.E.	1200	ped. type
1	30	West.	1750	SK-113
1	30	G.E.	2300	CD-85
1	15	Crocker Wh	1750	OCM, TEFC

SLIP RING MOTORS

QU.	HP	MAKE	SPEED	TYPE	VOLTS
1	500	G.E.	450	MT 422Y	2300
1	450	West.	1200	CW 4-30-9	220
1	350	West.	1200	CW	2300
1	300	G.E.	1170	1-15 A	4150
1	200	West.	585	CW	440
3	150	Al. Ch.	1760	AY-RW	2200
2	150	G.E.	500	1-16	4000
1	100	West.	1770	TEFC B.B.	220/440
1	75	West.	1160	CW 607	220/440
1	75	West.	600	CW 774C	220
1	50	G.E.	570	MT 553	220/440

SQUIRREL CAGE MOTORS—3 phase—60 cyc.

QU.	HP	MAKE	SPEED	TYPE	VOLTS
1	300	Al. Ch.	1200	ARW	2200
1	275	G.E.	1180	KT 550Bs	2200
2	250	G.E.	1790	KTEFC B.B.	2300
2	150	G.E.	1780	K 6325-S XP B.B.	440
2	100	Cont.	3570	NP 585-S XP B.B.	440
1	100	West.	1185	CEP 5306 B.B. drip	440/220
1	75	Cont.	3565	NP5065SX XP B.B.	440
1	75	G.E.	875	KT 553Y	440
1	50	G.E.	3530	KF 405Y Vert.	220/440
1	50	Cont.	3530	NP 445X XP B.B.	220/440

MOTORS—SYNCHRONOUS 3 ph, 60 cyc.

HP	SPEED	MAKE	TYPE	VOLTS
325	900	West.		2300
400	450	West.	HB	440
300	720	El. Mh. TEFC		2300
200/100	720/360	West.		4150
150	3600	G.E.	TS 956Y drip	2300
150	1800	G.E.	TS	220/440
150	900	West.		220/440
125	900	G.E.	TS 7536	2300
125	600	G.E.	TS 7641	2300
75	1200	Cr. Wh.	ALT B.B.	220/440

FOR POWER
J.L. HEMPHILL & CO.
1603 54th STREET, NORTH BERGEN, N. J.
PHONE NEW YORK—LONGACRE 5-3277
PHONE NEW JERSEY—UNION 3-2600

Circle 513 on Reader Service Card

OPPORTUNITIES!

in

New and used equipment recently released from service by a number of electric and gas utility companies

POWER PLANT EQUIPMENT
CONSTRUCTION EQUIPMENT
SUBSTATION EQUIPMENT
TRANSMISSION LINE MATERIALS

Send for new list . . . to

EBASCO SERVICES INCORPORATED
APPARATUS EXCHANGE
Two Rector St., New York 6, N. Y.

Circle 514 on Reader Service Card

BABCOCK & WILCOX COAL PULVERIZERS

2—NEW UNUSED Babcock & Wilcox coal pulverizers, Type E-56, each equipped with American Blower Corporation air fan, 15,000 cfm capacity with motor drive. These are complete coal pulverizer installations with blower air fans, attached and unattached structural parts, capacity 20,000# coal per hour each pulverizer. Exceptional bargain.

UTILITIES MACHINERY CORPORATION
1965 East Sixth Street, Cleveland 14, O.

Circle 515 on Reader Service Card

New R. R. car mounted. 650 KW, Diesel generator unit.

480 V., 60 cy., 500 KW Cooper-Bessemer and 150 KW Caterpillar. Complete power plant. Ready to go . . . $125,000.00

MIDWEST DIESEL POWER, INC.
4120 Belmont Ave., Chicago 41, Ill.

Circle 516 on Reader Service Card

RE-NU-BILT ELECTRICAL EQUIPMENT

53 YEARS SERVICE

MOTOR GENERATOR SETS

Qu.	KW	MAKE	RPM	AC VOLTS	DC VOLTS
2	4800	G.E.	450	2300/4600	250/300
1	2500	WHSE.	720	2300/4160	600
1	2100/2400	G.E.	450	2300/4600	250/300
2	1750/2100	G.E.	514	2300/4600	250/300
1	2000	G.E.	514	2300/4600	600/665
1	1500	G.E.	720	13200/6600	600
1	1500	Cr. Wh.	720	2300/4160	30/100
1	1250	WHSE.	720	2300/4000	600
1	1000	G.E.	900	2300/4000	600
1	1000	G.E.	900	6600/4000	260
1	1000	G.E.	720	2300/4000	275
1	500	G.E. Unused	1200	2300	300
1	500	G.E.	900	2300/4600	250
1	500	G.E.	900	440	250/125
1	350	G.E.	900	440/4160	125
2	300	G.E.	1200	2300	275
1	300	WHSE.	1200	2300/4160	600
1	200	G.E.	1200	2300/4160	250

FREQUENCY CHANGER SETS

Qu.	KW	MAKE	FREQ.	VOLTAGES
1	12500	WHSE.	60 To 25	13200-13200
1	5000	G.E.	60/50/60	11000-6600
1	2500	G.E.	60/24/60	2400-2400

3 PHASE 60 CYCLE MOTORS SLIP RING

	HP	MAKE	TYPE	VOLTS	SPEED
1	1750	G.E.	M-579BS	4800/2400	1800
1	800	G.E.	MT-428	2200	450
1	800	WHSE.	CW	550/2200	1776
1	600	WHSE.	CW-32D	440	1775
1	600	WHSE.	CW	440	850
1	550	WHSE.	CW	440	252
1	500	WHSE.	CW	2300	881
1	500	WHSE.	CW	550/2300	350
1	300	AL. CH.	ANT	2200	720
1	300	GEN. EL.	MTP-561	2200	1760

SQUIREL CAGE

3	1500	G.E.	K D.P.	2200	3580
1	1000	AL. CH.	ANW	2300	1180
1	550/275	WHSE.	CS-1115	2300	668/445
2	500	WHSE.	CSP-583H	D.P. 440	3600
4	500	AL. CH.	ARW-D.P.	2300	3600

OUTDOOR
G.E. METAL CLAD SWITCHGEAR
600 V. 3 POLE, A.C.B.

1—3000 AMP., AL-2-75, ELEC. OPER.
1—1000 AMP. AL-2-50, MANUAL
4— 800 AMP, AL-2-50 MANUAL
1— 400 AMP., AL-2-50 MANUAL
3—SPARE COMPARTMENTS

PUMPS — MOTOR DRIVEN

6—600 G.P.M. Gould, Figure 3360, 8 Stage, 2310 Ft. Head, 1000#, 3550 RPM, Each coupled to 500 HP 3-60-3550 RPM D.P. Sq. Cage Motor

2—WHSE, Type CSP-583H, 440 volt

4—Allis Type 2300 volt Magnetic Encl. Reduced Voltage Starters

BELYEA COMPANY, INC.
43 Howell St., Jersey City 6, N. J.
Phone: OL 3-3334—N.Y.C. RE 2-7180

Circle 517 on Reader Service Card

CHECK WITH WAGNER FIRST!

Thousands of new and "Certified Rebuilt" Motors & Generators in stock—up to 1000 H.P.
OUR 55th YEAR

A. C. MOTORS—60 CYCLE

HP	Mfr.	Type	Volts	Speed
800	Whse. (2)	Sq. Cage	2300	1800
750	El. Machy.	Synch.	480	514
700	G.E.	Slipring	2300	514
600	G.E.	Synch.	480	900
600	Elliott (2)	Sq. Cage	2300	900
500	Al. Ch. 3 brg.	Slipring	440	514
500	G.E. b.b. (2)	Synch.	2300/440	1200
450	Allis Ch.	Sq. Cage	2300/440	720
400	Whse.	Sq. Cage	2300	514
400	Marathon (2)	Sq. Cage	2300	3600
400	G.E.	Slipring	2200/440	600
400	G.E.	Synch.	550/2200	400
400	Whse.	Sq. Cage	440	1200
350	G.E.	Slipring	440	900
350	El. Machy.	Synch.	2300	900
300	G.E.	Slipring	220/440	514
250	G.E.	Sq. Cage	440	1200
250	Gen. Elec.	Sq. Cage	440	3600
250	Whse.	Sq. Cage	2300/440	600
250	Whse. (4)	Slipring	2300/440	600
250	Whse.	Sq. Cage	2300/440	400
200	Gen. Elec.	Synch.	550/440	400
200	G.E. b.b.	Sq. Cage	220/440	720
200	G.E.	Slipring	220/440	450
200	G.E.	Slipring	440	600
200	G.E.	Slipring	2200	900
200	Reliance b.b.	Sq. Cage	220/440	1800
200	Allis Ch.	Slipring	2200/440	720
200	A.C. TEFC	Sq. Cage	220/440	1200
200	G.E.	Sq. Cage	2300	450
150	Whse. b.b.	Sq. Cage	440	1800
150	Cr. Wheeler	Sq. Cage	440	450
150	Whse. XP	Sq. Cage	440	3600
150	G.E. (4)	Slipring	2200/440	600
150	Whse.	Slipring	220/440	1200
150	Allis. Ch.	Sq. Cage	2300	900
150	Whse.	Sq. Cage	220/440	1200
150	G.E.	Sq. Cage	2200/440	600
125	Whse. b.b.	Sq. Cage	220/440	900
125	A.C. TEFC	Sq. Cage	220/440	1800
125	El. Machy. (2)	Synch.	220/440	400
125	G.E. TEFC	Sq. Cage	2200	3600
125	Al. Ch. TEFC	Sq. Cage	220/440	600
125	G.E. (2)	Slipring	220/440	514
125	G.E.	Sq. Cage	2300/440	1200
100	Allis Ch.	Slipring	2300/440	600
100	Al. Ch. TEFC	Sq. Cage	2200	1800
100	G.E. b.b.	Sq. Cage	220/440	3600
100	G.E. (2)	Slipring	220/440	1200
75	A.C. TEFC	Sq. Cage	2300/440	1200
75	Cent. b.b. (8)	Sq. Cage	220/440	1200
75	G.E. (2)	Sq. Cage	220/440	720
75	G.E.	Slipring	220/440	600

D. C. MOTORS

HP	Mfr.	Type	Volts	Speed
250	Cr. Wh.	101-H	230	1150
200	Whse. b.b.	SK	250	257/575
150	Rel. TEFC b.b.	2550-F	230	850
150	Whse.	SK-210	230	330/1000
125/150	F.M. b.b.	DXZD	230	335/1200
125	G.E.	CD-173	230	575/1150
100	Elliott b.b. T.E.	JH-FE	230	1150
100	El. Dyn. b.b. (3)	30-S	230	450/1200
100	G.E. crane	CO-1831	230	675
75/100	Whse.	SK-191	230	300/900
75	Reliance b.b.	385T	230	850/1700
60	G.E. TEFC b.b.	CD-135	230	1150
30/40	L.A. b.b. (2)	ONW	230	500/1500

MOTOR-GENERATOR SETS

KW	Mfr.	Input V	Output V.
600	Allis Ch.	440 AC	250 DC
300	G.E.	440 AC	250/350 DC
200	Allis Ch. (2)	440 AC	250 DC
200	Whse. synch.	220/440 AC	55 DC
200	Gen. Elec.*	220/440 AC	125 DC
125	Whse.	220/440 AC	250 DC
100	Delco b.b.	220/440 AC	120/240 DC
80	Star b.b. Synch	220/440 AC	250 DC
75	Whse. Synch.	220/440 AC	250 DC
60	Ideal	220/440 AC	125 DC
50	G.E.	220/440 AC	250 DC
30	G.E. (2)	220/440 AC	125 DC
30	Whse.	220/440 AC	250 DC

Arthur Wagner Co.
Certified
MO nroe 6-7409
1435 W. RANDOLPH ST
CHICAGO 7, ILLINOIS

Circle 518 on Reader Service Card

LOOKING FOR A LOW-COST POWER PACKAGE?

If you are, then seek no more. Here's your opportunity to acquire the generating equipment you need at great savings. The recent conversion of a large downtown Chicago office building to Commonwealth Edison AC has made this like-new equipment obsolete. A systematic program of maintenance since installation has kept these units in excellent operating condition. We invite your inquiries and inspection of the following equipment:

1 DELAVAL TURBINE—Serial No. 255240, a 4000 rpm unit, direct-connected through a 890 hp, 4000-1200 rpm reduction gear to an Electric Machinery Co. 625 kva, 500 kw, 1200 rpm, 240v, 60 cycle, 3-phase synchronous generator, Serial No. 103052. Steam: 400 psig, 625°F; inlet; 150 psig B. P. Includes control board and synchroscope. Equipment was installed new in 1951.

1 ELECTRIC PRODUCTS CO. MG SET. Consisting of a 300kw, 250v, 1200 rpm DC motor Type L8571, Serial No. 67279 and a Type L8556, 300 kc, 208v, 60-cycle, 3-phase, 1200 rpm AC generator Serial No. 67278. Equipment installed new in 1951.

1 SKINNER UNAFLOW ENGINE—Serial No. 11430. Direct-conected to a Crocker-Wheeler, 600 kw, 150 rpm, 250 v, 2400 amp, 3-wire DC generator. Steam: 150 psig sat.; inlet, 5 psig B. P. Equipment installed new in 1939.

1 WESTINGHOUSE TYPE 5050 E 12 300KW MG SET—DC motor rated at 1200 rpm, 240v, 1250 amp; and Westinghouse 300kw, 208v, 1040 amp, 3-phase, 60-cycle, 1200 rpm AC generator. Equipment installed used in 1951.

MG Sets offered complete with DC and AC control boards.

OTIS BUILDING
10 S. La Salle St.
FRanklin 2-4716 • Chicago 3, Illinois

Circle 519 on Reader Service Card

38 Years Dependable Service

SLIP RING MOTORS 3 Ph., 60 Cy.

H.P.	Volts	Make	Speed
500	4000/2300	G.E.	600
450	4000/2300	G.E.	1200
400	2300/440	G.E.	600
400	4000/2300	Whse.	720
300	4000/2300	G.E.	720
300	440	Whse.	3600
250	4000/2300	Al. Ch.	600
200	2300	G.E.	600
200	2300/440	G.E.	720
150	440/220	G.E.	1200
150	2300/440	Whse.	720
125	2300	G.E.	600

AC GENERATORS or SYN MOTORS, 60 Cy.

H.P.	Volts	Make	Type	R.P.M.
400	2300	G.E.	TS	1800
400	2200/440	G.E.	ATI	720
300	2200/440	G.E.	TS	1200
300	440	G.E.	TS	720
150	440/220	Whse.	G	1200

SQUIRREL CAGE MOTORS

500	2300/4000	G.E.	FT	1200
500	2200/4000	Elliott	SC	1800
400	2300	G.E.	FT	3600
400	2300/4000	G.E.	K	1200
350	2300/4000	G.E.	BEDP	3600
350	2300/4000	G.E.	K	600
300(2)	2300	G.E.	FT	3600
300	2300/4000	L. Allis	FS	1800
300	2300/400	G.E.	KT	600
250	2300/4000	G.E.	K	720
250	2300/440	G.E.	K	1200
200(2)	440	G.E.	Dr-Pf.	720
200	2200	G.E.	KT	1800
200	2300	Cont.	TEFC	3600
150	440	El. Mchy.	Dr-Pf.	900
150	440	Whse.	X-pf.	3600
150	440/220	Cont'l.	X-pf.	1800
150	440/220	G.E.	TEFC	720
150	2200/440	G.E.	TEFC	3600
125	2200/440	G.E.	FT	1200
100	440	Whse.	TEFC	3600
100	440	Cont.	X-pf.	1800
100	2200	G.E.	FT	900

CIRCUIT BREAKERS, 3 Pole

2—1600 Amp., G.E., AL-50, 600 V., Air
1—1600 Amp., G.E., AL-50, 600 V., outdoor
1—1200 Amp., Whse., F-134, 7.5 KV, manual
1—600 Amp., G.E., 15 KV, Sol. oper.
1— 600 Amp., Whse., 7.5 KV, outdoor, New.

D. C. MOTORS

H.P.	Volts	Make	Type	Speed
150	280	El. Dyn.	B/brg.	600
140	250	G.E.	CD	650
90	230	G.E.	CD	1750

MOTOR GENERATOR SETS

KW	Make	Input., AC	Motor Type	Output V., DC
300	Whse.	4150/400	Syn.	250/125
150	G.E.	440/220	Syn.	250
125	G.E.	440/220	Sq. Ca.	125
100	G.E.	2300/440	Syn.	250
65	G.E. B	2200/440	Sq. Ca.	250

TRANSFORMERS 60 Cy.

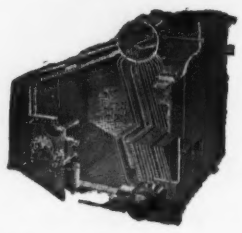
3—500 kva, G.E., 13,800—240/480 V.
3—200 kva, Mol., 13,800—2300 V.
3—333 kva, G.E., 13,800—2400 Y.
3—333 kva, G.E., 2400—240/120 V.
3—333 kva, Whse., 2400/4160Y—240/480 V.
1—300 kva, Whse., 4160—480 V., Dry, New
3—250 kva, Whse., 2400/4160Y—240/480 V.
3—200 kva, G.E., 2400—460V. Pyr.
3—200 kva, G.E., 13,800—480 V.
3—200 kva, G.E., 4156—480/240 V.
3—167 kva, Whse., 4156—480 V.
3—150 kva, Al. Ch., 2400—220 V.
3—150 kva, G.E., 13,200—2300 V.
1—150 kva, Whse., 4160—120/208Y V., 3 ph. Dry New
3—100 kva, Whse., 2400—240/480 V., Dry
3—100 kva, G.E. 2400—120/240 V., Pyr.

only partial listing

STEPHEN **HALL** & CO.
HARRY J. RICE, Pres.
625 ADAMS ST., HOBOKEN 2, N. J.

Circle 520 on Reader Service Card

BOILERS NEW UNASSEMBLED



# Steam/hr.	Key	PSI	Temp.
122,500	DF	565	850
121,650	DF	565	850
60,000	SF	435	750
74,000	H	280	500
55,000	A	240	—

DF Double Furnace, SF Single Furnace (illustrated), bent water tube boilers w/economizers and superheaters, B & W's and Foster Wheelers.

H Header type, straight tube, B & W.

A 3 drum, single furnace, Wickes.

Polnik-Loconti Industrial Supply, Inc.
315 Orlskany St., Yorkville, N.Y.
Utica, N. Y. Ph. RE 6-4621, RE 2-4513

Circle 527 on Reader Service Card

BOILERS

From the unfinished Battle Cruiser "Hawaii"

Material installed completely and never used.

8 Babcock & Wilcox Watertube Boilers

Approximately 157,000 lbs/hour. Working pressure 600#—850° T.T.—Oil-fired—with all boiler trim. Units are complete with fuel oil burning equipment—feed water pumps—feed water heaters, etc. Units are in prime condition.

CAN BE LOADED AS A UNIT OR DISMANTLED AND SHIPPED IN SMALLER SECTIONS

THE BOSTON METALS CO.
313 E. Baltimore St., Baltimore 2, Md.
ELGIN 5-5050 — LEXINGTON 9-1900

Circle 521 on Reader Service Card

FOR SALE

1050 KVA DIESEL UNIT

1050 KVA Nordberg supercharged diesel engine generator unit, 3 phase, 60 cycle 2400 volts, 327 RPM.

New 1947 — Excellent condition.

The above unit is still installed and complete with all auxiliaries as in operation. Can be adapted for dual fuel operation.

International Power Machinery Co.
1612 Union Commerce Bldg.—MAin 1-9514
Cleveland 14, Ohio

Circle 524 on Reader Service Card

BARGAINS!

1050 HP FAIRBANKS-MORSE DIESEL MODEL 32, 7 CYL., 257 RPM, 726 KW, FM 3/60/2400 WITH EXCITER, SWITCHBOARD, ETC. VERY LOW PRICE.

3000 CFM WORTHINGTON AIR COMPRESSOR 2 STAGE, HORIZONTAL, 164 RPM, 5 STAGE CONTROL. 650 HP 3/60/440 SYNCHRONOUS MOTOR. COMPLETE ACCESSORIES.

WHISLER EQUIPMENT CO.
1908 Railway Exchange Building
St. Louis 1, Mo.

Circle 528 on Reader Service Card

2—Hardinge 8'-8" x 70' rot. coal dryers.
3—G.E. 1000 KVA transformers, 1Ø, 13800-460 V.
3—Wagner 500 KVA transformers, single phase, 66000-460 volt.
1—Raymond 50" 5-roller hi-side mill, dbl. whizzer separator.
1—Babcock & Wilcox #32E coal pulverizer, airswept, 75 Hr.
2—E. Keeler 200 HP water-tube boilers, 160 PSI, Stoker-fired.
1—Gardner-Denver air comp., 445 cpm @ 100#, 6 cyl., 2 stage.

PERRY EQUIP. CORP.
1422 N. Sixth St.
Philadelphia 22, Pa.
POplar 3-3505

Circle 525 on Reader Service Card

COMPRESSORS

No better values at any price

100 CFM	150 PSI	6x7 Ing. ES-1
138 CFM	100 PSI	7x7, Ing. ES, CP & Joy
286 CFM	100 PSI	9x9 Ing. Worth. CP
294 CFM	125 PSI	9x9 Joy WG 9
321 CFM	125 PSI	10x11 Ing. ES-1
344 CFM	1500 PSI	Ingersoll ES-3
351 CFM	350 PSI	11-5x11 CP ICB-2
465 CFM	100 PSI	12x11-1R-ES-1" Chic. P.T.
502 CFM	125 PSI	12x13 Worth HB
593 CFM	125 PSI	13½-8½x8 Worth DC2
640 CFM	3000 PSI	Worth. DC-4
686 CFM	100 PSI	14x13 Ing. ES
877 CFM	125 PSI	17-10½x14 1R. XRB
1290 CFM	125 PSI	13-8x7 Joy WN 114 E 200 HP 3-60-220 or 440 Volt
2200 CFM	110 PSI	26/15x18 Chicago Pneumatic OCE .8PF 350 HP Syn. 3/60/4160

AMERICAN AIR COMPRESSOR CORP.
48th & P, North Bergen, N.J. UN 5-1397

Circle 529 on Reader Service Card

HI PRESSURE BOILERS

USED—NEW—PURCHASED—SOLD—RENTED 10-5000 H.P.

One of the Nations Largest Inventory

Indeck Power Equipment Co. 9750 N. Skokie Blvd.—Chicago (Skokie) Illinois—OR 3-7666

Circle 522 on Reader Service Card

AUTOMATIC and MANUAL
Gas or DIESEL GENERATOR UNITS
Complete Switchboard Design and Construction
USED & REBUILT EQUIPMENT
UNIVERSAL POWER ENGINEERING CO.
382 Wayne St. Jersey City, N. J.
Phone: DElaware 2-8300

Circle 523 on Reader Service Card

MOTORS • GENERATORS
TRANSFORMERS
NEW • REBUILT
ELECTRIC EQUIPMENT CO.
WORLD'S LARGEST INVENTORY
CALL COLLECT CL 4-9058
P. O. BOX 51 • ROCHESTER 1, N. Y.

Circle 526 on Reader Service Card

We own and offer Power generating equipment

1—1785 KVA vertical Skinner engine
1—1250 KVA West. condensing-extraction turbine
1—875 KVA horizontal Skinner engine
1—625 KVA Worthington non condensing turbine
1—715 KVA West. non condensing turbine
1—500 KVA G.E. non condensing

Steam coditions on above vary from 140 to 400 lbs. 750 degrees.

WHITE ELECTRIC MOTORS
LOWELL, MASS.

Circle 530 on Reader Service Card

ELECTRICAL POWER EQUIPMENT

SQUIRREL CAGE MOTORS

3 ph. 60 cy. 220 or 440 volts

(*2200 volts or higher)

HP	RPM	MAKE	VOLTS	TYPE
1500	1800	Al.-Ch.	2300	Ventilated
1250	3600	Al.-Ch.	4000	DP/PF
800	600	West.	2300	CS-44
600	600	West.	2300	CS-12
500	1800	G.E.	2300	KT-565Y
500	1200	G.E.	2300	FF-567
350	3600	Cr.-Wh.	440	SO-68
350	1200	West.	440	CS-22556H
200	900	West.	440	CS-874S
200	720	G.E.	440	KF-564S

SLIP RING MOTORS

3 ph 60 cy 220 or 440 volts

HP	RPM	MAKE	VOLTS	TYPE
1500	514	Al.-Ch.	2400	Mill
1000	1200	Al.-Ch.	4000	Any
1000	900	Al.-Ch.	2300	Any
600	1800	G.E.	4160	M-6345-S
500	1200	G.E.	440	M-6345-Z
500	900	G.E.	440	IM
350	1800	Al.-Ch.	2300	ARY
250	720	G.E.	4000	IM
200	720	G.E.	2300	MT-566

MOTOR GENERATOR SETS

KW	MAKE	MOTOR GENERATOR A.C.V.	D.C.V.
1750	G.E.	4160/2300	250/300
1000	West.	4160/2300	250
750	G.E.	4160/2300	250
600	G.E. (3 unit)	2300/440	125/250
500	G.E.	2300	250
400	Al.-Ch.	2300/440	125/250
250	G.E.	2300	250

50 YEARS 1910 · 1960 SERVICE TO INDUSTRY

Write for current complete stock lists on electrical power equipment you need or send your list of surplus and used equipment for our offer.

Phone CAnal 6-2900

CHICAGO Electric Co.

1320 W. CERMAK ROAD • CHICAGO 8, ILL.

Circle 531 on Reader Service Card

FEATURED ITEMS

BOILERS

44500 #/hr CE 450 PSI @ 750°F NEW
35000 #/hr CE 285 PSI @ 577°F NEW
18000 #/hr Keeler CP 160 PSI
620 #/hr Cyclotherm 250 PSI

MOTORS—Class I Group D

350 HP Al. Ch. 3/60/2300/450 RPM
250 HP Cont. 3/60/2300/720 RPM
250 HP Al. Ch. 3/60/2300/3600 RPM
250 HP G.E. 3/60/2300/3600 RPM
200 HP G.E. 3/60/2300/3600 RPM
150 HP Al. Ch. 3/60/2300/3600 RPM

AIR COMPRESSORS

7500 CFM @ 42.5 PSIG Al. Ch. Cent. 1250 HP
1360 CFM @ 35 PSI Worthington YO 150 HP

TRANSFORMERS

2000 KVA Al. Ch. 33000—2400 3/60—(2)
500 KVA Al. Ch. 2400—480 3/60
6000 KVA 44000—4160 3/60 Substation

NATURAL GAS ENGINE GENERATORS
(Can be seen running)
1250 KVA Rathburn Jones—3/60/2400-4160

GENERATOR SETS

1250 KVA G.E. 3/60/2300/3600 Cond. 200 PSI
540 KW West. any Voltage—Cond. 200 PSI
750 KW 3/60/2200/900 RPM 250 V DC MG Set

HEAT & POWER CO. INC.

60 East 42nd St., New York 17, N.Y.
310 Thompson Bldg., Tulsa 3, Okla.

Circle 532 on Reader Service Card

WATER TUBE BOILER & UNDERFEED STOKER

In excellent condition 150 HP Keeler C.P. design 160 psi. Can be seen operating Toledo, Ohio.

THE LUMM CORPORATION
3151 South Ave., Toledo 9, Ohio EVergreen 5-2527

Circle 533 on Reader Service Card

MISS POWER EQUIPMENT SAYS,

"For BIGGER SAVINGS and BETTER SERVICE, Get Our BARGAIN PRICES on Guaranteed NEW and REBUILT MOTORS"

SQUIRREL CAGE MOTORS NEW AND GUARANTEED

HP	Make	REBUILT	Type	Speed
500	G.E.	S.B. Open	IK	1200
400	West.	B.B. Drip	CSP-681	1800
400	L.A.	B.B. Splash		1800
400	G.E.	S.B. Open	IK	1200
400	West	S.B. Open	CS	900
350	West.	B.B. Drip	CS-22556H	1200
300	L.A.	B.B. Splash	FX-1468	1800
300	G.E.	S.B. Open	IK	1800
300	Reliance	B.B. Drip	AA-6085	1200
300	G.E.	S.B. Open	IK	900
300	Cont.	B.B. Splash	N-804	900
300	G.E.	S.B. Open	IK	720
300	G.E.	S.B. Open	KT-561	720
300	G.E.	S.B. Open	IK	600
250	G.E.	S.B. Open	KT	1800
250	West.	B.B. Splash	CS-875	1800
250	G.E.	S.B. Open	IK	1200
250	G.E.	S.B. Open	IK	900
250	G.E.	S.B. Open	IK	720
200	L.A.	B.B. Drip	2200V OGX-118	1800
200	West.	S.S.B. Open	CS-855	1800
200	West.	S.B. Open	CS	1200
200	G.E.	S.B. Open	IK-15	1200
200	G.E.	S.B. Open	IK-158	1200
200	G.E.	S.B. Open	2200 v. IK	1200
200	G.E.	S.B. Open	IK	900
200	A.C.	B.B. Open	AR-826	1200
150	West.	TEFCBB	CS-871.5	1800
150	G.E.	S.B. Drip	K-6324	1800
150	West.	S.S.B. Open	CS-771-C	1800
150	Al. Chal.	B.B. Open	AR	1800
150	West.	S.B. Open	2200V CS	1800
150	West.	B.B. Drip	CS-772	1200
150	West.	TEFCBB	CS-775	1200
150	G.E.	B.B. Open	KT	1200
150	G.E.	B.B. Open	KT-587	1200
150	Al. Chal.	B.B. Open	AR-828	900
150	Cont.	TEFCBB	N-743-X	900
150	Al. Chal.	TEFCBB	AZ	900
150	F.M.	B.B. Open	H-24A	900
150	G.E.	S.B. Open	IK	900
150	G.E.	S.B. Open	IK	720
125	G.E.	TEFCBB	K	3600
125	Burke	B.B. Open	440 Volt N-505	3600
125	Reliance	T.E.F.C. B.B.	AA-5084	1800
125	G.E.	S.B. Open	IK	1800
125	G.E.	B.B. Splash	K-505	1800
125	Al. Chal.	B.B. Open	AR	1800
125	Reliance	B.B. Drip	AA-5084	1200
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125	Century	B.B. Drip		1200
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125	Ideal	B.B. Open	A-806	1200
125	F.M.	B.B. Open	H	900
125	G.E.	S.B. Open	IK	720
125	G.E.	S.B. Open	IK	600
100	G.E.	B.B. Splash	K-445	3600
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100	Reliance	T.E.F.C.B.B. New	AA-445U	1800
100	G.E.	S.B. Open	KT-343	1800
100	G.E.	B.B. Open	K-504	1800
100	Cont.	TEFCBB XP	NP-505	1800
100	Al. Chal.	B.B. Drip	ARW-823	1800
100	G.E.	S.B. Open	KT-347	1200
100	Ideal	B.B. Drip New	A-584	1200
100	West.	B.B. Open	CS-607	1200
100	West.	S.S.B. Open	CS-754-C	900
100	Al. Chal.	T.E.F.C. B.B. XP	23E8	900
100	F.M.	B.B. Open	H20C	900
100	Al. Chal.	B.B. Open	AR-823	900
100	F.M.	B.B. Open	H	720
100	F.M.	B.B. Open	H	600
75	West	B.B. Open	CS-445	1800
75	Reliance	TEFCBB	AA-504	1800
75	G.E.	B.B. Open	K-505	1200

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PHONE or WIRE us COLLECT
LARGE LINE OF SLIP RING MOTORS & CONTROLS.

POWER EQUIPMENT CO.

8 CAIRN STREET • PHONE BEverly 5-1662 • P.O. BOX 534 • ROCHESTER 2, N.Y.

Circle 535 on Reader Service Card

POWER EQUIPMENT

20000 KW, *NEW*, Gas Turbo-Generator 3/60, 13800 V, 3600 RPM, Immediate shipment
1500 KW, Elliott, Cond. Turbo-Gen. 3/60, 2300 V, 5000/1200 RPM, 250 PSIG,. 525°TT, geared.
1000 KW, G.E., Non C. Tubo-Gen. 3/60, 2300 V, 3600 RPM, 400 PSIG 600°TT, 90-125 PSIG Exh.
300 KW, .60 PF, G.E. Cond. Turbo-Gen. 3/60, 2300 V, 5917/1200 RPM, 400 PSIG, 600°TT, geared.
1000 KW, G.M. 16-278A, Diesel Units (2) 3 Ph. 60 Cycle, 2300 V, 720 RPM
300 KW, G.M. 8-268A, Diesel Units (2) 3 Ph. 60 cycle, 480 V, 1200 RPM

BREW, WOLTMAN & COMPANY, INC.

50 CHURCH ST., N.Y. 7, N.Y.

Circle 534 on Reader Service Card

DIESEL ENGINES

1 HEAVY DUTY NORDBERG

Type TSM—model 32118—1700 HP @ 180 RPM — 21½" x 29". Unit complete with all pumps and coolers. Can be used for generator drive, producing 2400 HP @ 225 RPM. Equal to new. Presently in Maritime Academy.

1 UNUSED G.M. 12-278A

1200 HP — 8¼" x 10½" — 12 cylinder — VEE type — 2 cycle — 750 RPM — left hand — serial 50428. Excellent unused and fully guaranteed late type engine.

THE BOSTON METALS CO.

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ELGIN 5-5050 — LEXINGTON 9-1900

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REWOUND · RE-DESIGNED
MANUFACTURED

Ask for our Stock List

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3—2500 KVA G-E 69000—2400/4160Y
3—2500 KVA G-E 69000—7200/12470Y
4—2500 KVA W-H 34500—2400/4800/11000
3—1500 KVA G-E 69000—2400/4160Y
3—1500 KVA G-E 69000—7200/12470Y
3—1000 KVA G-E 34500—7200/12470Y
3— 833 KVA W-H 43800—480

THE ELECTRIC SERVICE CO., 5322 Hetzel St., Cincinnati 27, Ohio
"America's Exclusive Independent Transformer Service Shop"

Circle 537 on Reader Service Card

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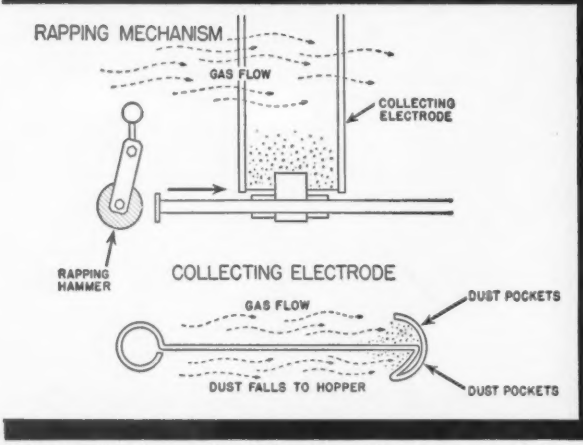
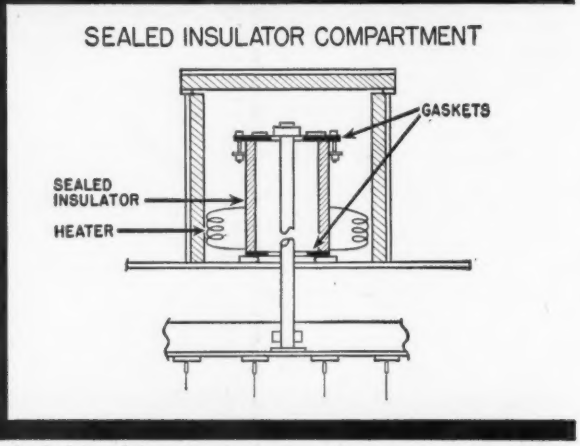
SOME PLAIN FACTS

ABOUT SUPERIOR PRECIPITATOR PERFORMANCE

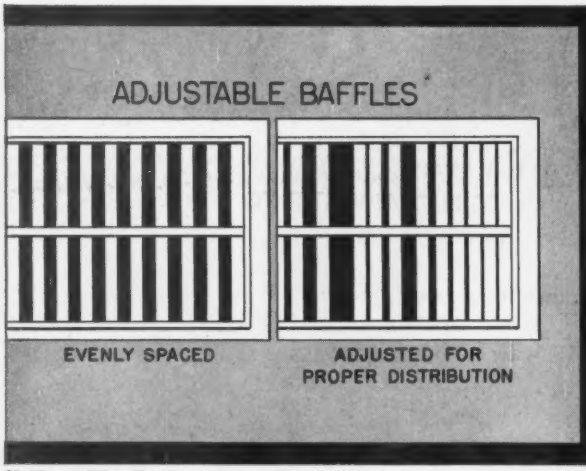
Buell Precipitators are designed and constructed for rugged service and superior performance. Frills and internal frim-fram of a doubtful value are eliminated in favor of strength and simplicity. The casing, outside supports, and internal parts are of rugged construction; and the four-point suspension of emitting electrodes ensures the greatest stability. Here are just a few of the outstanding features of Buell Precipitators.





Effective Continuous Cycle Rapping—Yes, it's mechanical. A simple, rugged system free of complicated gadgets; assures positive dust shearing action. Each row of electrodes is rapped separately—in the direction of the gas flow—on a continuous cycle. Dust is sheared off, drops in an agglomerated mass and pockets on electrodes minimize reentrainment.

Sealed Insulators Improves Operation—High voltage quartz support insulators are completely sealed; prevents gas and dust leaking into insulator compartment and outside air leaking into precipitator. There is no need for costly ventilating systems. Thermostatically controlled electric heaters insure start-up without danger of moisture condensation and insulator breakdown.



Uniform Distribution of Gas Flow—Field adjustment capability is vital. Buell's adjustable baffle permits final positioning after field measurement of actual flow distribution . . . because gas flow patterns are not entirely predictable. The Buell distribution system assures equal gas loading through the precipitator; eliminates ineffective "dead" areas around passages and prevents "sneak-by."

Buell Spiralectrodes cut maintenance to a minimum. Buell's record stands at less than 1% replacement in this key area. Self-tensioned spiralectrodes eliminate vibration and "off-center" swaying, often prevalent with weight-tensioned wires. They're structurally fixed and once installed stay in alignment. The spiralectrode provides greater emission than straight wires.

Buell precipitators are simple and effective. They're designed for continuous service. You'll be glad you turned to Buell when you experience superior performance and low maintenance. Detailed literature describing all features is available.

buell Norblo

The Buell Engineering Co., Inc., Dept. 50-D, 123 William Street, New York 38, N. Y. Northern Blower Division, 6428 Barberton Avenue., Cleveland, Ohio. ■Electric Precipitators ■Cyclones ■Bag Collectors ■Combination Systems ■Fans ■Classifiers.

For more facts circle 327 on Reader Service card, p 103

accuracy

ASHCROFT DURAGAUGES measure pressure with precise accuracy no matter how severe the conditions of service

Ashcroft Duragauges are available in pressure ranges from 15 psi (or vacuum) minimum to 100,000 psi. Dial sizes: 4½" through 12".

sustained

The Bourdon tube in Ashcroft Duragauges is manufactured to precision standards of flexibility and mono-linked to the rotary movement. When pressure flexes the tube, the gauge pointer is always positively positioned, because it is mounted on the geared center shaft of the movement. Sustained high accuracy and long life are assured.

Choose your Ashcroft Duragauges made of components best suited to your needs. Eight Bourdon tube materials are available. Movement of stainless steel with nylon bearings and pinion gear for longest wear. Case materials: special aluminum alloy or tough phenol plastic.

The unique "Maxisafe®" Duragauge provides absolute protection to the viewer, plus easy and quick access to the mechanism. Your industrial supply distributor will help you select the best combination of components for your Ashcroft Gauge requirements. Phone him today or write for Catalog 300B.

MAXWELL MANNING M&M & MOORE INC. TRADE MARK

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A product of

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Gauge and Instrument Division • Stratford, Connecticut

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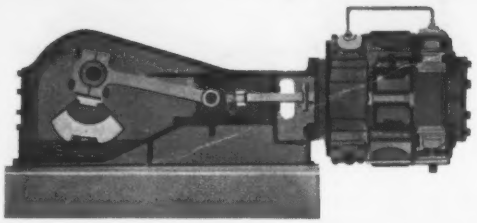
Latin America: Export Division, Chrysler Building, New York, N. Y.
Europe: Manning, Maxwell & Moore, S. A., Fribourg, Switzerland

For more facts circle 202 on Reader Service card, p 103

Circle 203 on Reader Service card for following ad ➤



HIDDEN VALUES?

Are they all in Worthington Horizontal Compressors?

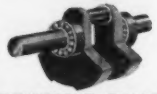
Frankly, they're not. And we're glad! One of the "hidden values" listed below we'd hate to sell—see if you can tell which one it is. (Correct answer on page 196.)

On the other hand, we're extremely happy to be selling horizontal compressors with the other 24 "hidden values" built in. (Not everyone does.)

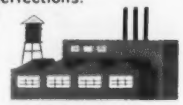
Frankly, we could drop many of these and 99 users out of 100 might never know it. But the 100th could suffer untold expense . . . so we keep them all for everyone. To buy these "hidden values", please contact your local Worthington representative next time you specify a compressor. Worthington Corporation, Compressor and Engine Division, Buffalo, N. Y. 36-10

SALES AND SERVICE INTEGRATION recognizes kinship of one to the other. One man administers both.

MAGNAFLUX AND MAGNAGLO inspections are widely used to expose surface imperfections.



ADJUSTABLE ROLLER MAIN BEARINGS feature low friction losses which help to extend compressor life.

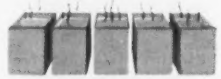


INTEGRATED DIV. includes foundry, manufacturing, sales, service and engineering in one location.

FEATHER VALVE — industry's preferred compressor valve—is efficient, quiet, and low in maintenance.

CAPACITY CONTROL —choice of simple by-pass, through dual to complex sequential control systems.

FLEXIBILITY — oil or non-lube; single or multi-stage; Worthington MVD, direct or geared drive.



PARCO-LUBRITING of critical wearing surfaces completely eliminates most start-up scuffing problems.

ULTRASONIC TEST — an advanced method of examining certain critical parts for internal quality.

ACCESSIBILITY — valves, packing and main parts are easily observed and reached by operators.

ONE-PIECE FRAME includes built-in housing with full foundation support to minimize stresses.

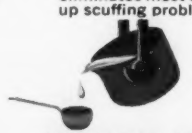
2000 CRAFTSMEN, these units built by same men who design and build large 5000 hp, 15,000 psi units.

KOLENE PROCESS removes impurities from crankpin bearing shell that weaken bond to babbitt.

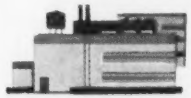
OPTIC COMPARATOR is used to check connecting rod bolt threads for uniform angles, lead and form.

FACTORY ASSEMBLY and shop run-in on air insure proper operation and reduce installation costs.

FINISHED GROUND BEARING SHELLS provide crankpin positive full-contact backing for long life.



COMPOSITION TEST determines constituents of molten iron in each ladle before any casting is poured.

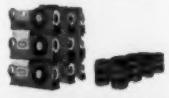


$1,000,000 ADDITION TO LABORATORY assures sound equipment designs based on actual research.

COUNTERWEIGHTED CRANKSHAFT eliminates vibration and insures a smoother operation.

DISTRIBUTORS — over 200 in major markets give local supply and close contact with Worthington offices.

FULL-FLOATING WRISTPINS in piston give minimum piston and cylinder wear and reduce maintenance.



STOCKING PROGRAM standard air and gas gathering units are kept in stock to give short shipments.

PROFILOMETER inspection of highly finished parts assures easy break-in and long life.

THERMODYNAMICS SECTION analyzes special application to size unit and determines performance.

DESTRUCTION TEST of complete compressor cylinders verifies engineers' design calculations.

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